Виктор Колупаев «Пространство и время для фантаста»

298	94

Space and Time for the Science-Fiction Writer

by Viktor Kolupaev

Translation of «Пространство и время для фантаста»

“…Not one of you has tried, going back to the beginning, to determine if the path you were on was the .right one, not having noticed if that path was the necessary one. On the contrary, all of you went in the steps of those going before you, as if you were a flock of sheep following their leader, instead of looking immediately, at the very beginning, upon entering if it was the right path on which to step out…

But, in the name of Athena, we hurl everything that I've said, and we wait here—let it be cast to oblivion…”

Lucian. “Hermotimus, or, The Rival Philosophies” [«Гермотим, или О выборе философии»]

FOREWORD

I don’t need to contemplate Time according to some plan. No matter what I would do, no matter what I would think, the old riddle is constantly recalled, that which worried me, made me happy and tormented me. Indeed, with a second layer of consciousness (subconscious?) somehow I contemplate Time—Space and Time.

Probably, there is nothing special about what I think. I am not alone. Consciously or unconsciously everyone thinks about it; however, they are only the most trivial thoughts: "Oh! Already it’s six o'clock! " "Recently I had a birthday, and already the next one is coming." About the quick passage of time, about the irretrievable loss of time, and the inability to stop it, or at least stretch it out of course everyone thinks about. Hence, the sadness, the melancholy—these human emotions are the most informative for me. When I’m sad, my thinking ability is high.

In the seventh or eighth grade, now I do not remember exactly the first time I discovered that there are Space and Time. Day, night, a year, the distance to school and the forest—it is all I knew, of course, and even earlier. They were commonplace, natural and understandable. But here is Space, in which the stars themselves live, and Time, the whole Universe itself, in which I also live. It impressed and affected me my whole life.

All day the snow fell. It had been warm, and suddenly it cleared up and abruptly turned cold, but the air still felt damp. I was walking home from school. Our house stood on a hillside, so it looked from the street like a one-story house, but out in the

yard it became a two-story one. We lived in the last apartment on the second floor with windows overlooking the railway station. From the place where I went, the view opened out on the railway station, the railroad tracks, clogged with trains. There were spotlights on the steel supports, a viaduct, and the depot. Down there something thundered, clanged, and droned with shimmering lights.

I stopped and looked up slightly, then higher, then looked up all the way as far as I could. Right here I was stunned. I did not realize what had happened. I suddenly saw the sky’s extensiveness. Some stars were close; others further away; but those in a third group barely flickered at all from the bottomless depths. They were variously colored: blue, yellowish, red, almost white. They formed some strange shapes, signs, mysterious calligraphy in the sky. And the sky was beautiful, indescribably beautiful, beautiful beyond expression and spooky at the same time with its immensity. I saw the stars a thousand times before, and they had always been beautiful. But that night some hidden and incomprehensible sense in them appeared to me.

I already knew that the stars are suns that are far, far away. And now I realized that their number is infinite. Shocked, I stood on the street for about two hours. And frost chilled me to the bone through a cotton jacket and quilted trousers. My toes froze in footwear that was patched and sewn two layers thick. My fingers clenched into a fist and then opened again. But I kept standing there and watching, sometimes turning in place and occasionally fixing my cap when it was falling off my head.

A star is a huge, beautiful sun. I'm on a spaceship approaching it to fly around it, and behind it is a second one. Further out there is a third one, a thousandth, a millionth, a billionth one. And so it is forever! I hurtle infinitely long in an infinite empty Space inhabited by stars, and yet this is only an infinitely small part of what is ahead that is waiting for me.

An eerie delight gripped me. A delight and fear of infinite Space and Time. And in that I believed at once that they are endless. A different, finite picture of the cosmos I could not imagine. After all, if there is a limit to the world, then there must still be something beyond this limit! Later I realized that it is impossible to imagine the infinite. And then I was sure that I had imagined, understood, and realized it. And I was amazed at the beauty and simplicity of Space and Time. This infinity accepted by me was a "bad infinity," as Hegel defined it. But, of course, I had not heard anything about Hegel then.

Then came the thought of death. But at fifteen years old, death seemed incredible, impossible. How can I not be? That everything remains, but not me?! This idea then tormented me for a long time, however. I was in no hurry to get the answer. If this is unavoidable, I will see then...

But Space and Time, other worlds, stars and planets were quite another matter.

Still, the frost drove me home. But since then, the starry sky never ceases to amaze me with its mystery and beauty. Although on that night I learned *everything* about

the Universe, Space and Time, I wanted to make sure that I was right. So I got my own personal books, and the first books I bought were books on astronomy.

I studied the starry sky. The very names of the stars and constellations fascinated me. Vega, Lyra, Mizar, Alcor, Regulus, Sirius, Cassiopeia, Orion… I still remember something. Reading the book, I learned not only about the stars, but also a lot about what I had not imagined before: matter in general, cosmic storms, the "main" stellar sequence, the super-dense state of matter of white dwarfs, multiple star systems. All of this was interesting, and I wanted to learn more and more, but for the most part, I was right. The Universe was indeed endless. Matter existed in infinite Space and Time. I wasn't even upset by the fact that the idea at which I arrived had been known a long time ago. Let it be so. I, however, made the discovery myself.

This was a bright, naive, happy time ...

It's needless to say that in school my favorite subjects were physics and astronomy.

But soon I began to have doubts. The first one was the law of inertia. It seemed boring to me. How was it possible? If a body is not affected by some external force, won't it move endlessly in a straight line in the infinite Space? I learned the proof of this law from a book, but when I left the classroom to answer, I stood and could not open my mouth. I stood in silence until I got a "D". It seems that it was my only "D" at school--in physics.

By the tenth grade I accumulated a lot of questions. And the concept of a static infinite Universe did not satisfy me. Would Space and Time still exist if all matter were removed from the Universe? Did Space and Time have a beginning? Can Space and Time change in any meaningful way? I already realized that this had nothing to do with cubic meters or the clock's rate. In short, my picture of the world, which once shocked me was falling apart, but a new one had not evolved.

Now, I realize that I did not have any support from which I could push myself up. I just wanted to understand right away with some inner enlightenment what Space and Time are. You see, Nature (I did not believe in God), how *this* interests me, how painfully I brood over *this*! What would it cost you, even if you won't give me a clue, then at least to push me in the right direction, toss me a subtle hint, or suggest something imperceptibly?

The mystery had not been discovered. A childlike, but irresistible desire to understand everything—even in this short period of time—occurred. This was not a tragedy for me. It was just that the mystery was more complex than I had expected. Well, then I needed to work calmly, not rushing, and thereby not working in the same manner as before.

I graduated from college. Then a family, new concerns, and new friends appeared. I started a completely different life. So, the problem of Space and Time became secondary.

My first library of children’s books was gone. I began to collect a new one. Books mainly on radio electronics, science fiction, and literature on physics were included in it. Cosmology, the theory of elementary particles—it seemed to me that somewhere here lay the key to Space and Time. I remember how happy I was when I first read about the Big Bang hypothesis. It was not a scientific (or even a popular scientific) work, but rather it was a critique of the false bourgeois doctrine that sought to drag the Old Man into the cosmology. This was the beginning of Time and Space, and the beginning of the Universe! It was interesting and exciting. That was something!

It must be borne in mind that this is how it was at that time. Here are a few quotes from the scientific literature from back then, which I, of course, read later. I won’t name the authors.

"Abram Ioffe does not know how to apply the Marxist-Leninist theory of knowledge and the dialectical method. Yakov Frenkel worships bourgeois science. The same is true for Moisey Markov "

"Bohr and Heisenberg differ from fascist Jordan in their philosophical positions only by exercising greater caution and masking their viewpoints."

"Einstein declares himself a supporter of the reactionary theory of the expanding world."

"Einstein, slipping into the philosophy of idealism, begins to bring in all sorts of reactionary drivel."

"Einstein, Friedmann, Lemaître, de Sitter, Eddington, Milne and others maintain that space-time as a whole allegedly has curvature and that allegedly it is closed and, although it is not limited, it is finite. Spherical, cylindrical, unsustainable, expanding or pulsating universe models were created—models met with exultant clericalism as confirmation of the idea of creation and the inevitable destruction of the world."

Cybernetics was only just beginning to become a real science from a pseudoscience. And Trofim Lysenko still dominated biology. Everything in the world was considered from the point of view of dialectical materialism. Anything that could not be measured had no right to exist. There was a funny (or scary) fact: I was already studying at the Institute, and Albert Einstein was still alive. But I did not know about him. He was not mentioned in the textbooks.

I lived, worked, and meditated. The mystery of Time and Space remained a mystery. Periodically I gathered colleagues for solving this problem, then the group would break up. I simply did not know which side I should approach it from. I followed an irregular path. Space and Time for me were certain entities, which needed to be realized. I was in the grip of the substantial conception of Space and Time. I fought over both continuum and discrete models, all in vain. And even when I moved from the substantial conception to the relational one, where Space and

Time appear with some relationships in the physical world, a wall still remained in front of me and there were no cracks in it.

And then I started to write science-fiction stories. Probably, if you follow the psychoanalysis, in my subconscious there was some kind of "substitution". I wanted to write science fiction for a long time and wrote my first story when I was almost thirty. Generally, almost all of my stories and novels are about Space and Time, and even about Mankind. The main thing that science fiction gave to me was some kind of liberation of consciousness. I gradually learned to think in an unconventional way.

It just so happens that in adulthood I became acquainted with the special theory of relativity in a statement made by Albert Einstein himself. In school I did not suspect that such a scientist Einstein existed. We did not have a course on the special theory of relativity at the institute. Good popular fiction (at least some of what I came across) appeared only in the 60s. But by this time, truth be told, I already had read something about Einstein and his STR, but most of what I read concerned the various paradoxes, superluminal signals, and other "fiction." The physics literature accumulated in my apartment. I hunted "Einsteinian collections almost exclusively."

But life continued on. Engineering work fascinated me. In 1976, I was admitted to the Union of Soviet Writers. I had published collections of science-fiction short stories and novels, including some published abroad. Everything was fine. Only I still could not solve the mystery of Space and Time.

In 1973, Alexander Stoyanov brought me two volumes of the "Collected Scientific Works" of Albert Einstein. [«Собраний научных трудов»] They are still standing on my shelf. Now I could examine the special theory of relativity in text that was not paraphrased. And though by this time I was already well versed in STR, the first two volumes of the collection shocked me. I looked at the third volume (already in my library) primarily only briefly. Well, but the fourth volume was altogether a delight!

I wrote the phrase here, "... it is well understood in SR [special relativity]" and realized I had made a significant inaccuracy. Yes, I could coherently express SRT [special theory of relativity] and at the very time that I "understood" it, "I realized that I don’t understand anything.” Of course, SRT is logically complete; the theory is a simple and perfect mathematical tool. But something bothered me ... no, not bothered, on the contrary, made me happy, something that I saw in it that others didn’t see. But there was something that I myself could not understand. Something in it was secret, hidden and at the same time strikingly apparent, lying in plain sight. Of course, if, for example, a function itself is specified, then it is possible to substitute any numeric values, not doubting that you’ll get the right answer. But the function itself ... Does it change? Does it have one and the same meaning at different times? I read, pondered, grievously and joyfully. And this grievous joy or joyous torment led me on. Something happened in my subconscious, something in there matured.

Just like everyone else, I was prone to the influences of other people even though I did not notice it or recognize it later. As a science-fiction writer, Aleksandr Grin and

Ray Bradbury exerted the most influence on me. And among the philosophers were Immanuel Kant, Blessed Augustine and Gottfried Leibniz who helped me. This will become clear from what follows.

Then one day I started thinking about what the speed of light is and how to measure it? Of course, I knew about mass in the experiments to determine the speed of light. I knew that all of the experiments verified its stability. But I got to thinking about what it was that we are measuring when we measure the speed of light. The question probably seems crazy to many. But it was interesting to me. And then the breakthrough came. It was on March 14, 1979. Yes, on the birthday of Albert Einstein, in his centennial. There is no mystery or cryptic coincidence here. It was simply that the closer that this day came, the more articles and books about Einstein and his scientific writings appeared, and the more intensely I pondered this question.

At this time I, like others of my kind in their primary work, spent much time in the Scientific Library of Tomsk Polytechnic Institute. And I read, of course, not only what the work required, but also that which interested me. I remember well that day. I worked in the library from morning until lunch. Visitors at this time were usually few. Besides, it generally was a beautiful and comfortable library. I went out to smoke in the empty smoking room. I was going from corner to corner in there, and suddenly I understood everything. I understood what the speed of light was, how to measure it, how it is related to Space and Time. I realized just what Space and Time were! Immediately there were many conclusions that sprang up. I already knew why in our world "delayed" interactions only are present; why a cause precedes its effect; why entropy increases in a closed system; why galaxies, which are actually quasars, rotate; why time flows from the past to the future; what kind of connection there is between Space and Time; and much more. All of this happened in a moment.

Just about the same thing happened to me every time the plot of a story came into my head. It came suddenly. I felt it in its compact form. That is, everything from its first to its last letter is already there (although I rewrite my stories many times); I knew the whole plot even though the words did not yet exist. The plot, rolled up into a point, I carried in my head for many months or years until the time for words arrived. Then I sat down and wrote the story in a day, or two or three, according to its size.

So here it is. I know everything. But this *everything* has been compressed into a point. This is a very strange situation. It is as if I were carrying within myself some happy secret.

I didn’t smoke any longer than usual that day. I returned to the reading room, picked up a book, and went home at the usual time. I knew that it would be useless to start writing right now. The "point" simply would not take shape in words. I would need to wait.

But I never anticipated that I would have to wait so long.

At first, I rushed to look in the literature: Did I miss what had long been known to others? It turned out that some physicists and philosophers came very close to this idea, but for some reason stopped. Concurrently I began my ordering of physics. I was interested in problems in physics, which physics tried to explain, or which problems are left far behind and long ago already "did not make sense." Along the way I discovered that I know physics very badly. I had to do this and that. But I rarely looked in textbooks where these difficulties in physics are treated, and I wasn’t interested. I realized that I needed to study the works of the people who established physics. They never hid the problems standing before them. I developed my systematization of physics, which turned out to be around five hundred sections. More than three thousand articles and books were there in my file cabinet. All of this took time. And then in 1982, I left for good the engineering work and cast my lot with fiction. I would satisfy my scientific curiosity at my own expense.

Several times I began to develop my idea, but I could not. Truth be told, separate paragraphs remained, but the overall picture had not evolved. I was drowning in a huge amount of information, dreamed of a personal computer, began to realize that I did not consider some important point, which had long been used by the subconscious mind, because everything there is conveniently folded, but the point had not yet entered into my consciousness. Only in 1991 did I say to myself, “Yes, so all that ensues is that the concepts of Space and Time are not just relational, but they are subjectively relational.”

And then I wrote without much difficulty a draft of two thousand pages. I realized that this work must be only for myself as my last systematization of physics. Then I wrote a normal, I think, scientific work "Space and time (physical aspect)". But it is a very brief and fictionalized narrative of the problem of Space and Time. I suggest it to readers only to draw attention to my main work.

So did I decide the eternal problem of Space and Time? I made only one step forward. But it was a difficult step, it demanded a serious breaking of stereotypes in physics.

I hope that someone will support me and continue the work. I still have some particular ideas, but another problem troubles me, the solution of which I, as always, felt compressed into a point.

It took me forty-two years from the first delight and reverential consternation over Space and Time to take steps toward their explanation. If indeed I made a mistake, then this is a most tragic one, but it is also the most beautiful mistake in my life.

298	94

Chapter One

SPACE AND TIME IN PHYSICS

"... So just what is this “time”? Who could explain it simply and concisely? Who could mentally comprehend it so that he could clearly talk about it? To what, though, do we refer in conversation, completely normal and familiar, if it is not time? And when we talk about it, of course we understand what it is, and when someone else speaks about it, we also understand his words. So, just what is this “time”; if I wanted to explain to the one asking the question, I would have to say, ‘I don’t know’ However, I insist that I do *know."*

Saint Augustine, "Confessions" [«Исповедь»]

Representations about matter and its attributes—space, time, motion, causality, interaction, and other things—underlie the physical picture of the world.

One of the shortcomings of the traditional form of physics is the intuitive character of initial physical concepts, of which the strict determination does not exist. Of course, the development of physics periodically leads to a situation in which attempts are being made to clarify them, such as in the special theory of relativity for example. But some success very quickly leads to the situation in which these concepts are again beginning to be used as if they are completely certain. Physics goes so quickly forward that it does not seem to have time to stop and look back in order to ask the question: what is behind there? On what basis is the structure of physics being built?

The intuitive, poorly defined nature of the initial axioms is as much a second shortcoming as these considerations that follow, for example: time is homogeneous; space is homogeneous and isotropic. And furthermore, it is inexplicable. Why, for example, does the cause produce the effect, and not the other way around; why are there retarded potentials and not advanced ones; why does the entropy of a closed system increase?

Of course, for some scholars such questions do not exist. Advanced potentials are discarded as having no meaning. The direction of the flow of time is determined by the totality of the phenomena in the world, etc. But this is not an answer.

The intuitive nature of the initial axioms by itself is probably not a tragedy for physics. The downside is that fact that the excessively long ones are not specified

and are not derived logically from some new, more thorough axioms, which, in turn, the development of physics can be purely intuitive at this stage, until the time comes to define them logically, again on the basis of more thorough intuitive axioms.

And the third shortcoming of the traditional structure of physics is the lack of a unified picture of the structure of physics as a whole. This is recognized by all physicists.

The relevance of the study of space and time values in the axiomatization of physical theories is undeniable. There is no branch of physics that would not use these concepts. All of physics in its fundamental basics builds on the idea of space and time. Furthermore, they are primary, undefinable concepts. Isaac Newton did just that by introducing absolute and relative space and time into the axioms, into the laws of motion. But these concepts of space and time are not only the most important elements of the very structure of theory in physics, but they themselves are defined by the corresponding axioms. Here we first meet with the so-called "circular logic", when some theory is based on concepts that can be determined only on the conclusions of the theory itself.

It is known that determining the concept means to bring it under another, broader concept. Our everyday understanding of space and time, as well as their definitions used in modern physics, are inextricably linked to such specific properties, such as the *neighborhood* property allowing us to judge about the existence of two points (phenomena, entities) and the *sequence* property of their conditions. It is impossible to say beforehand that these properties are inherent in all levels of the material world. Space and time are never observed just by themselves.

Modern images (the mathematical model) of space and time are these. It is assumed that any span in space has infinite divisibility inasmuch as space appears to be an infinite set of points placed so tightly that they form an infinity that is continuous. In continuous space (the continuum), each point has a neighborhood, and no matter how tightly we bind the point to its neighborhood, it will still contain an infinite number of other points. Furthermore, the mathematical model requires that neighborhoods, not overlapping each other, can be set up near two distinct points. In the continuum, one can expand the property of dimension. Real three-dimensional space, from a mathematical point of view, does not limit the number of dimensions that space might have. There is even a branch of mathematics (with applications in physics), dealing with spaces of infinite dimensions.

Continuous space has the property of *connectivity*. The space can be "connected" in many different ways. For example, the surface of the torus and the spherical surface are connected spaces in the sense that for either of them any two of points can be connected to each other by a continuous curve, which will lie on the same respective space. But the properties of connectivity in these two cases are different. A simple closed curve (such as a circle) can always be with a continuous form drawn together into a point on the surface of a sphere, but this does not always happen on the surface of a torus. It is believed that that region of the Universe, which is now available for our observation, is connected simply, like the surface of a sphere.

Another important property of real space is *orientability*. It is known that a glove for the left hand cannot be turned into a right-handed glove, no matter how much we have twisted it unless we turn it inside out. Moreover, even if we would send the glove to a remote part of the Universe and then bring it back, the left-handed glove upon its return would not become right-handed one. However, in such a type of mathematical spaces changes in orientation may occur. An example is the Möbius strip, which is a two-dimensional space. A left-handed glove will turn into a right-handed one if it moves in a closed curve along this strip. Mathematically, you can analogously enter a three-dimensional “Möbius space". A Möbius strip is a non-orientable space. It is believed that no evidence exists that our Universe is non-orientable.

All these properties are known as *topological* ones. They are only connected with the continuity of space, but not with its characteristics such as size and shape. But in order to build an adequate model of the real Universe, we need its *metric* characteristics. One of the most obvious and practically useful characteristics of space is a method by which points of space can be marked by continuously changing symbols, or *coordinates*. The space, in which the concerted continuous coordinates are specified, is called a *manifold*.

Real space, besides the fact that it is a manifold, still has *geometrical structure*. For example, between any two points there is a shortest path. Furthermore, lengths and angles may be determined. Spaces having these properties are known as metric spaces. There are many different types of metric spaces: Euclidean, Riemannian [differential geometry], Lobachevskian [hyperbolic geometry] space, etc.

Time to a large extent has the same properties as that of space. Apparently, the properties for them are the same, for example, such topological properties like continuity, connectivity and orientability, although time is not three-dimensional but *one-dimensional*. Time also has a metric structure, since it is possible to determine the "distance" between two points in time as an interval between two events, the *duration*.

But what physically determines the topological and metric properties of space and time is still unknown. This in fact is the mystery of time.

Over a period of centuries, the *continuum model* remained the most acceptable model of space and time. The concepts of the spacetime continuum play a significant role in modern physics. All of the physics of the macrocosm is of the continuum model. The general theory of relativity included the space and time of the Universe’s objects in the continuum. Quantum physics has done the same with the microcosm’s space-and-time objects and processes.

However, the development of quantum theories as well as the general theory of relativity leads to the fact that the concepts of the spacetime continuum deal with considerable difficulties. Quantum physics needed to borrow the idea of a point, an unextended elementary object, from classical physics. By itself, this unextended point is only a kind of mental construct. However, endowed with properties such as

mass or charge, it acquires the status of an object of physical reality. This unextended point is the primary abstraction of the continuum. But unextended points, particles, can interact immediately with only one point, at the place where they happen to be. Moreover, it does not matter whether they interact with particles or continuous fields. This is the so-called *principle of locality*. It mandates that all physical laws must be described by higher-order differential equations (or operators).

But the identification of concepts of objects' pointedness and their interactions with reality has already dealt with difficulties in classical physics. Setting a finite mass or a finite charge in some unextended point in space, we thereby create in it a peculiarity, a "singularity": at this point arise infinitities, i.e. densities of masses and charges, gravitational and electromagnetic fields that are physically meaningless.

Overcoming these difficulties was tried by looking for categories of space-time discreteness. But here even more significant difficulties were expected for physics. If the interaction is not localized in unextended points, and within some finite length (the rudimentary area of space), then a model of discrete space is received. But here another difficulty arises. In these rudimentary areas of space, no matter how small they were, an infinite speed of expansion of physical interaction is obtained in that the interaction occurs in all areas of the expanse of space. This assumption is contrary to the generally accepted *principle of short-range interaction*, which maintains that any physical interactions can expand only at a finite speed, not exceeding the speed of light in vacuum.

Physicists have learned to circumvent these difficulties, but they only circumvent them, and not eliminate them, with the help of so-called *renormalization*. The essence of renormalization is the distinction of its physically meaningful and its "non-physical" (infinite) parts of the calculated result of the physical quantities. However, the meaning of renormalization is not yet fully understood.

Thus, on the one hand, in the physics of elementary particles, for example, the ideas of the continuum are used; and on the other, there are concepts about a certain spread of quantum objects and processes. But so far not a single experiment in quantum physics found an electron of any size. This particle actually manifests itself as occupying zero volume.

A different understanding of the essence of space and time has led to substantial and relational concepts of space and time.

The *substantial* concept regards space and time as a special kind of essence or non-corporeal substances. This concept includes certain separate containers, in which the material objects and processes are placed. They exist by themselves, completely independent from the matter, the field, and the interactions between material objects (e.g., the void of Democritus, the absolute space and time of Newton); or are in some dependence on them (e.g., the special and general theory of relativity of Einstein). Nevertheless, they have a significant impact on the existence and movement of material objects and systems. The idea of space and

time in this construct are fundamental without further analysis of any other categories. The question of real, physical content of these concepts is not even raised.

The relational concept considers space and time as some relations between material objects and physical events. In this concept, space and time have no independent existence and appear by consequences, the result of the interaction of material systems. Here it is already possible to raise the question about the physical meaning of the concepts of space and time although so far it has not yet been done. The most consistent supporter of the relational concept of space and time was Gottfried Leibniz.

Static and dynamic concepts characterize the different points of view on the relationship of space and time, on the one hand, the creation, change, extinction (or more succinctly, evolution) of existence, as well as the occurrence of material systems in general, on the other.

According to the *static* concept, there is no difference in meaning of the status of existence between the events of the past, present, and future. They all exist in reality and "simultaneously". The difference between them is about the same as the difference between the different points of the space. Our consciousness, moving along its world line from the past to the future, in some way "encounters" various events. This moment of meeting by our consciousness is experienced as "present time", "current time" or "now."

No objective appearance and disappearance of events and material systems exist at all. It is only an illusion that occurs at the moment of the meeting of the consciousness with one or another event. The disappearance of an event or object means the removal of consciousness from the meeting place to the event in the space-time continuum.

According to the *dynamic* concept, in reality there are only events of the present time. Events of the past no longer really exist; the future events do not exist yet in reality. The entire set of real events and material systems, which makes up the Universe, moves in time—from the past through the present to the future, actually arising and disappearing, turning into other events and material systems. When Newton formulated the basic concepts of classical mechanics, in particular the concept of absolute time, the dynamic concept became viewed as the only possible scientific concept of time. One of the fundamental arguments against it is that none exists in present physical theory; no physical law provides objective criteria for the allocation of the present time. It does not have a concept of evolution.

Whether time and space appear in objective reality or both are constructed by the human mind, the perception of space and time, in any case, is a mystery for man.

There is yet another pair of concepts. The concept of *objectivity* of space and time considers that time and space are objective properties of the real world. A common demonstration of this lies in the fact that if the spacetime phenomenon is generated

only by human consciousness, then the development of an objective character is deprived in nature. One may object that there may be a "something" in nature that is transformed into what we call time and space only in the mind of man, just as in nature there are fluctuations in the electromagnetic field of different frequencies that we perceive as color. And this corresponds to the *subjective* concept of space and time.

Saint Augustine believed, however, like most philosophers, that time is being created by our consciousness. Apparently, he was one of the first who drew attention to the fact that the emergence of the concept of "time" would be impossible without the presence of memory in humans. Moreover, Saint Augustine believed that not only the concept of time in humans, but also the "external" time itself, which has duration and which can be measured, too, is impossible without the existence of memory.

The substantial concept of space and time undoubtedly is closely linked with the objectivity of space and time, and perhaps in some sense it is one and the same thing. Similarly, the relational concept is closely linked with the subjectivity of space and time.

Immanuel Kant developed most strictly the idea about the ideal and subjectivity of time and space. First of all, it must be noted that Kant thought that anything that can be given to our senses (externally, in space; internally, in time), we contemplate it only the way it appears to us (the phenomenon), and not as it is in itself (the noumenon). In his transcendental aesthetics Kant above all sets apart empirical intuition. It separates in knowledge everything that the mind thinks through its concepts, so that there was nothing left besides experiential contemplation. He then separates from the empirical intuition everything that belongs to sensation—so that only pure intuition remains, as only one form of the phenomena—the only thing that can be given by a priori sensuality. As a result, it turns out that there are two pure forms of sensuality intuition as principles of a priori knowledge, namely, space and time. Space, according to Kant, does not at all represent a property of any things in themselves; it is not a definition that belongs to the things themselves or that even remains in that case if we digress from all subjective conditions of intuition. Only from the human point of view can we talk about space, about its expanse, etc. This predicate can be attributed to things only in that case if they appear to us, that is, if they are objects of sensuality. We have the full right to say that space encompasses all the things that appear to us externally (phenomena), but we cannot claim that it encompasses all things in themselves (noumena) independent of whether or not those things are contemplated, and furthermore, independent of whomever or whatever appears as a contemplating subject. The same applies to time.

I barely touched on the problems of space and time. This was done with the sole purpose to show that these ill-defined concepts indeed do lie in the foundations of physics. Do these problems lead to some difficulties in physics itself? Undoubtedly they do. Later I will try to give a brief analysis of several difficulties in physics, those "forgotten" or "making no sense”. Generally speaking, you can start with any of the accepted properties of space and time for example, the spatial homogeneity or its

isotropy, but this is also possible to do with the homogeneity of time. As a result, we still come to one and the same situation. But it is most interesting to analyze some of the physical theories from the point of view of the direction of the flow of time and its irreversibility.

Chapter Two

THE DYNAMIC “ARROWS” OF TIME

"I have lived this day! Tomorrow, whether with a cloud
Or the bright sun, let Jupiter fill the sky.
All the same, he has no power,
To turn it back, whatever has now happened;
To undo what was done before,
However quickly time has rushed by.”

Horace (Quintus Horatius Flaccus), "To Maecenas" [«К Меценату»]

We must always consider that the fundamental concepts of classical physics—space and time—came into the science from everyday language and their meaning in life and in science is significantly different. The conception of the "flow" of time belongs to the same kind of expression. The most striking metaphor for the flow of time is the flow of a river, of water. Water flowing from a clepsydra [a water clock] was the most accurate kind of time for an ancient Greek or a Roman. A drop of two levels allows the flowing of the water. And always it is in one direction: from a higher level to a lower one, then an even lower level. The same applies to a river.

The *irreversibility* of time is understood as having the presence of an *unequivocal* temporal form, that is, as the *uniqueness* of the direction of time’s flow for the sequence of events.

Rudolf Clausius, William Thomson, Ludwig Boltzmann, Josef Loschmidt, Ernst Zermelo and others had discussions of this issue in the framework of theoretical physics of the last century. Likewise, the research of the twentieth century right up to the work of Nobel laureate Ilya Prigogine and his school showed the complete indifference of mathematical time of theoretical physics in all its fields, beginning with mechanics and ending with cosmology and quantum physics, to the real direction of the flow of material processes.

All local laws of physics are symmetric with respect to time reversal. Nevertheless, in the real world around us there is a clear temporal asymmetry. Arthur Eddington called this asymmetry the "arrows" of time. In this chapter we will briefly consider the dynamic "arrows" of time:

1. The "arrow" of time in classical mechanics.

2. The electrodynamic "arrow" of time.

3. The "arrow" time in quantum mechanics.

4. The cosmological "arrow" of time.

The causal and thermodynamic “arrows” of time will be examined in subsequent chapters.

Classical physics from a mathematical point of view represents the theory of second-order differential equations. New physical theories of the twentieth century, from a mathematical point of view, came to be interpreted as theories of invariants of certain groups of transformations. But up until this time the most sophisticated theories in physics are based on concepts and structures developed in the analytical mechanics of the XVIII—XIX centuries, such as *action, Lagrangian and Hamiltonian functions, variational principles, etc.*

Wave dynamic equations in classical and quantum mechanics, electrodynamics, and cosmology are *reversible in time*. They have two solutions: "retarded" and "advanced". An illustration of the retarded solution, for example, in classical mechanics will be the waves on the surface of a pond created by a thrown stone. In electrodynamics there are spherical waves that expand from a radiation source. No one has ever seen waves on the water surface converging to one point or spherical electromagnetic waves coming from infinity and disappearing back into the absorbing source. For cosmology the "retarded” solution is met in the form of the expanding Universe. The "advanced" solution, however, would be consistent with a contracting Universe.

There is a somewhat more complicated case in quantum mechanics. The dynamic equation, Schrödinger’s equation, is reversible in time and accordingly allows the evolution of the wave function in either of two mutually opposite directions for time. But one of the problems of quantum theory is the so-called "reduction of the wave function". Before the process of macroscopic observations the wave function would allow a number of potential opportunities. For example, in an experiment with two slits an electron can get to any point on the screen. However, in the process of monitoring the results of the experiment all of these capabilities instantly "shrink to a point" that one of them somehow implemented. This phenomenon is called reduction of the wave function.

John von Neumann developed the idea that there is an unanalyzed element in the quantum-mechanical measurement. In addition to the causal measurement obeying the Schrödinger equation, the wave function undergoes a discontinuous, acausal and instantaneous change due to the intervention of the observer and his effect on the object.

This to some extent is similar to the explanation given by Niels Bohr of the existence of spectral lines. He proceeded from the assumption that the photon emission occurs as a result of a sharp transition from one quantum state to another state with a lower energy. He assumed that the electron, before it makes a spontaneous transition, may remain for some time in a certain quantum state (the so-called "lifetime" of an excited state); however, at the same time he suggested that the transition itself happens instantaneously, that it occurs without any kind of intermediate state of the electron, and that in this case the word is about the process. "which cannot be described within the framework of space and time." This thesis was confirmed later in the interpretation of wave mechanics by the Copenhagen school. Generally, we cannot say that an electron is in a certain state, and all the more so that it achieves one or another transition. The transition is manifested only in the measuring operation, which introduces into the action a complex system formed by an electron, a photon, a device that records it, and an observer who monitors the device. The electron before measurement is "potentially distributed" among all of its initial states with a definite probability for each one. And just at the moment when the observer records the arrival of a photon having a certain frequency in his device, he thereby brings about an instantaneous reduction in the bundle of probabilities and may confirm that the appropriate quantum transition took place.

The assertion has been expressed that the instantaneous change of the wave function at its measurement is in conflict with the final velocity of the interaction’s spreading. Albert Einstein, for example, thought it paradoxical, inconsistent with our ideas of space and time. However, the majority of physicists think that it is out of the question there is any spreading of the action here. The wave function is not any real field, and its sudden change is not a physical process of change in this field.

However, analysis of the so-called Einstein-Podolsky-Rosen paradox, John Bell’s inequality, Alain Aspect’s experiment and other researchers have shown that the non-locality of an interaction of quantum objects still implies some instantaneous "non-force" and "non-informative" interaction.

But let’s return to the very dynamic "arrows" of time. The paradox between the nomological reversibility of equations and their actual irreversibility in our world, of course, long ago has already drawn the attention of physicists and philosophers. Desperate attempts have been taken to bring the unidirectionality and irreversibility of time from the symmetric equations themselves. Such eminent physicists as Paul Dirac, John. Wheeler, Richard Feynman, Jayant Narlikar and many others participated in this work. The attempts did not lead to success. In all cases, it was necessary to resort to special boundary conditions, based on the principle of causality, or to thermodynamics, namely, to that experimental fact that the entropy in the future is greater than that in the past. Roger Penrose has shown that this is true even for reduction of the wave function.

Now one can make the disappointing conclusion that the dynamic arrow of time does not appear as “arrows” at all. **From time-symmetric equations it is impossible to deduce the cause of the directional effect and the irreversibility of time, if no asymmetry entered it earlier. Moreover, one**

often forgets that the solution of any wave equation does not simply suggest a "retarded" or "advanced" solution, but its sum total. And if the conditions in the future and the past are too symmetrical, then this solution is equal to zero, i.e., neither advanced nor retarded action exist; nothing happens in the world; the world itself simply does not exist.

Chapter Three

THE CAUSAL “ARROW” OF TIME

"... If such a mortal were to be found who was able to survey the entire chain of causes with his spirit, that person could not make a mistake. For he who knows the reasons for future events undoubtedly knows what will happen in the future ... This no one can do other than God ... "

Mark Tullius Cicero. "On Divination." [«О дивинации»]

It seems that there is no simpler concept than "causality". Most (and maybe all) of our actions are initiated by some sort of causes; or on the other hand, we act this way, and not otherwise, to obtain a certain effect. It is true that mistakes happen, unfortunately, but it is not causality that is at fault, but, apparently, it is we ourselves. The intuitive connection between "cause and effect" is quite understandable to us.

An overwhelming number of authors believe a fundamental and indisputable principle, according to which is that *the same causes, under the same conditions, produce the same effects*. The laws of physics are considered to be such principles that from the characteristics of the state at a given instant of time they allow one uniquely to obtain the characteristics for any other instant of time. It can be said that the uniqueness of causality is the uniqueness of the physical laws.

By combining causes and effects into one concept of cause, one can come to the confirmation that "the cause is equal to the effect". But from the equality of causes and effects it follows that any arbitrarily distant cause of a specific effect in a chain is equal to it (the effect) and therefore contains within itself the conditions uniquely determining its advent. In order to know the whole causal chain, it is enough to know any event within the sequence: it already contains all of the information about the past and the future of this chain. This idea, coming from ancient Greek philosophy, was embodied in many physical laws. *One may also consider the principle of equality of cause and effect as a kind o formulation of conservation laws.* Furthermore, Bertrand Russell drew attention to the fact that this principle is simply a tautology. Namely it leads to so-called Laplacian determinism.

One needs to note that this principle, on the one hand, seems self-evident, because it is on it that all (or almost all) physical laws and our practical activity indeed are based, but, on the other hand, it would seem to contradict the fact that the world has the ability to evolve.

Cause-and-effect relations are based on the idea *of the precedence of the cause to the effect* in the sense that any idea of the occurrence of the phenomenon is a representation of its conditionality coming from the past and the present, but not from the future. The formal explanation can even go from the future to the present and the past; however, the answer to the question of how the process flows is always bound with the pointing of the effect from the past to the future, but not vice versa. The unidirectionality of causation is considered to be connected with the essence of the very concept of causality as the reflected direction of possible activity. The concept of irreversibility is bound closely with the notion of unidirectionality of the cause-effect relationship.

The problem of the precedence of effect to cause is not seriously considered in the scientific literature, although the exotic embodiment of this idea (tachyons) has already generated an enormous amount of literature.

The physical principle of causality—one of the most common principles of science—establishes the permissible limits of the influence of physical events on each other. This formulation consists in the requirement that an event occurring in some region of spacetime can have an influence on the evolution of a physical system only at subsequent moments of time. It includes as a particular case a condition of microcausality since within the framework of relativistic-invariant theories, it excludes the possibility of superluminal velocities as well as the inversion of causal relationships. The physical principle of causality also requires the absence of a reciprocal influence of such events, as applied to which the concepts "earlier" or "later" do not have meaning. According to the special theory of relativity, it is precisely this situation that arises when the spatial distance between events is so great and the time interval is so small that these events could be connected only by signals propagating faster than light. The required absence of a causal connection between [the events], whose joining the signal may implement, leads to a conclusion about the impossibility of movement with a speed that exceeds that of light in a vacuum.

In the mechanism of physical theory, the physical principle of causality is used primarily for the selection of boundary conditions to the corresponding equations of dynamics, which ensures uniqueness of their solution, that is, the selection is of a *retarded*, rather than an *advanced*, action.

The essence of the principle of "retarded" causality lies in the fact that the cause precedes the effect. That is, the physical principle of causality *is* the principle of retarded causality. A great number of works have been devoted to its theoretical proof, but there is still no satisfactory explanation of this thesis. Supporters of the fundamental existence of only retarded causality sometimes refer to the finiteness of the speed of interaction. If there were not a definite time interval between cause and effect, then there would not be any advancement. This is an extremely significant observation. Nevertheless, it does not speak favorably of retarded causality, but rather of causality in general

There is a concept of *complete* or *symmetrical* causality, from which it follows that the effects are able to precede as well as follow their causes. From this point of

view, the *retarded* and *advanced* causality are completely equivalent. Theoretically yes, they are equivalent. But something, some property of some interaction so categorically separates them, so that only *retarded* causality exists in our world.

So, let's remember that retarded causality exists in our world only de facto, and not nomologically. And now let's see whether it is demonstrative that the direction, existing in philosophy and physics, is regarded that the basis of the direction and irreversibility of time is indeed the retarded causality. This is the so-called "causal" concept of time, or the causal "arrow" of time.

The causal concept of time began to be developed long ago, even as far back as being in the works of Leibniz and Kant. Kant believed that the concepts of cause and effect are the only condition for the determination of the requisite sequence in time. Causality itself, like the a priori concept of reason, presupposes, in his opinion, the necessary connection of the precedence of the cause to its actions, since otherwise the causal connection would be a subjective play of the imagination.

Max Born believed that the abstract, timeless sense of causality is fundamental. There are many supporters of the causal conception of time. But in order to establish its validity, it is necessary to figure out whether it is possible to understand the physical significance of the primary asymmetric causal relationships used in this hypothesis without using any temporal conditions that this hypothesis is intended to determine.

The main position of the causal concept of time is based on the following proposition: the cause precedes the effect. It is not difficult to see that circular logic is present in this assertion. When they say that the cause precedes the effect, it is manifestly understood that the effect appeared later than the cause, that is, they use the notion of temporal precedence, which is still only needed to be deduced. To distinguish the cause and effect in a language that does not use any time criteria is impossible.

And yet, attempts to bring a temporal order from a causal one do not stop. One such attempt is Hans Reichenbach's interpretation of this concept on the basis of the "mark method". But, as Adolf Grünbaum showed, this method turned out to be untenable because of the circular logic in the arguments. Grünbaum himself made another attempt, having generalized the concept of time by excluding from it a feature of temporal order founded on the relation "earlier" and "later", and introducing as a fundamental relation of a specialized relationship "between", which, in his opinion, does not suggest temporal order. Nevertheless, as a result, he had to introduce boundary conditions first that, in fact, are nothing other than the classical temporal relationships "earlier, later", and, second, a criterion for the establishment of causality, which constitutes the second principle of thermodynamics.

Despite the apparent failure for justification of the direction and irreversibility of time with the help of *retarded* causality, such attempts are undertaken again and

again, but no one has managed to avoid the **circular logic** in reasoning or the link to thermodynamics.

As far as it is considered that the physical principle of causality lay and will always lie at the foundation of any natural-science theory, it would be interesting to analyze whether it leads to any difficulties in physics.

The laws of classical mechanics were developed in the works of Galileo Galilei, René Descartes and Isaac Newton. Newton gave them the modern mathematical form bringing mechanics into the system. The law on *inertial* motion, which is the first law of Newton's mechanics, states that a body remains in a state of rest or uniform straight motion until some external forces act on it. That is, if the body is left to itself, it will not stop its motion, as Aristotle thought, but will continue the motion until some force causes it to deviate from it or even stop.

Newton's mechanics rejects Aristotle's principle: "everything that is movable is moved by something else." Instead, it recognizes the idea that motion can be causeless. It can, of course, be said that the cause of uniform and straight motion is precisely that fact that no forces act on the body, but this is just an attempt to avoid a solution to the problem of inertial motion.

If the inertial motion is causeless, then this fact is in conflict with the expression of the principle of causality, according to which every phenomenon has a cause. The difficulties associated with the problem of inertia and causality are so great that it allowed Richard Feynman to say: "... free movement has no apparent cause. Why objects can always run in a straight line, we do not know. The source of the law of inertia still remains a mystery." [***Note that while the translated quotation apparently captures Feynman's meaning, it very likely does not capture his exact words***.]

From the mathematical point of view of Newton's second law, putting a force acting on a body equal to zero, one can obtain a motion with a constant velocity, consequently there is, motion by inertia. In this deducibility of the principle of inertia from the second law of mechanics, many discern an internal connection between the conservation of the velocity and the principle of causality in mechanical motion. But in this case the first law is simply a particular case of the second, becoming incomprehensible that its significance so great in physics.

For that reason many authors attribute a separate meaning to the first law. The main argument of supporters of this idea is that the case when a force does not act on the body is a special case and it should become the subject of a special analysis. The point is that the laws of mechanics are valid only in regard to a system that either rests or moves uniformly. Only by having adopted as a basis the existence of such systems can we say that physical values have an explicit meaning and a precisely defined content.

In formulating the second law of mechanics, Newton, of course, met this fundamental difficulty: how can one fix the reference frame in which its acceleration

is measured? Newton could not have a priori physical grounds for the distinction of inertial and non-inertial reference frames. That such a difference exists in nature can be demonstrated in many ways. Newton considered the so-called experiment with a bucket. Rotation of the bucket has a nature that is relative. If one observer sees the bucket as rotating, another (for example, someone sitting on the bucket) can assert that it is not rotating. In Newton's experiments, this difference was made absolute. If the bucket is suspended on a string and the string is twisted, then after we release the bucket, it starts to rotate. If water is poured into the bucket, its surface will bend and get depressed in the center, [the water climbing up the sides of the bucket]. This absolute effect demonstrates the presence of forces of inertia and allows us to distinguish between inertial and non-inertial reference frames. But Newton did not know why such a difference exists. However, he used it to postulate the so-called absolute space. In fact, we are dealing here with a special inertial system, and all accelerations relative to this system can be detected due to the presence of forces of inertia.

However, the concepts of space and time are first introduced by Newton at the level of primary terms, but then they receive their determination by means of axioms even though they are defined because they specify the background for the realization of the axioms themselves. After all, the laws of motion of classical mechanics are valid only in inertial reference frames, which are self-determined as systems moving inertially with respect to absolute space and time. We again are faced with *circular logic* in reasoning, this time in an attempt to determine inertial motion through absolute space and time, which in turn can be determined only through inertial systems.

Attempts to return the causal basis to inertial motion led to the appearance of other determinations of inertiality, but nobody has yet managed to escape from the ***circular logic*** in reasoning.

One may call the traditional form of the law of inertia, one of space-time. But this law can also be given a different term, namely a momentum-energy one: the body retains a constant momentum and energy until it transfers part of its energy and momentum to other bodies or fields, or until it acquires some amount of energy and momentum from other bodies or fields. The constancy of the energy ensures the uniformity of motion. The constancy of the momentum ensures the straightness of the motion. Here it is as if we are dealing with the classical form of equivalence of the space-time and momentum-energy descriptions.

Thus, the principle of inertia appears as the first clearly formulated law of conservation. But if the momentum-energy formulation is correct, we are faced with a new difficulty: the *laws of conservation* of momentum and energy are non-causal. But it is precisely the conservation laws which are considered to be the fundamental causal description by the overwhelming majority of physicists and philosophers. And it was precisely on the basis of the idea of causality that conservation ideas developed later formulated in special conservation principles. Again we meet with **circular logic** in reasoning.

The Euler-Maupertuis principle of the least action in the absence of external forces contains the requirement of an extremum for this very action, which gives a state of its rest or its uniform straight motion. Thus, the law of inertia and the *variational principles* of mechanics are closely connected. But after all, the causality of inertial motion still remains an unsolved problem. Does this indicate that the variational principles themselves, their reliability, arise as the problem?

On the basis of the concept of inertia, Newton introduces the concept of force (cause), which produces the movement of bodies and the change in their motion. The second law of Newtonian mechanics says that a force acting on a body is equal to its mass, multiplied by the acceleration. From this law it follows that knowing the forces acting on the body or system of bodies during the motion, as well as their coordinates and velocity at a given time, one can determine the coordinates and velocity of the body or system of bodies at any time. The causal relationship presented in this differential equation expresses the state of any system as a function of time and acting forces. The concept of causality in this law is identified with a dynamic pattern. As is commonly assumed, it clearly shows the meaning of the classical Laplacian determinism.

As far as I know, no one raised the question of whether a pure Laplacian world is possible with deterministic events alone. That is, is it possible for a strictly deterministic development, even if it is not of the world, but of a mechanical system in a mechanical sense? And not even any development, but simply existence.

On the one hand, it is accepted that all events of our world must be causally determined. On the other hand, in the real world there is constant change (evolution or degradation), which in most cases is orderly as well. Modern physics is built on the principle: *the same causes under the same conditions give rise to the same effects*. Here a difficulty immediately arises: in what way does change happen in the world? Suppose that the cause changes. But why can the cause itself change? It is because the previous cause has changed, with which our cause appears to be the effect?

That, in turn, will require changes in its cause, and so on to infinity. But first of all, the assignment of the "cause of all causes" to infinity is methodologically unacceptable; this is the so-called "bad infinity". Secondly, the very link to the infinity of the world is invalid, because this world (at least, our Metagalaxy) is finite in space and in time. Thus, the attraction to the problem’s solution of an endless succession of causes is, in fact, simply a departure from the problem’s solution. The same reasoning is applicable to the unequal conditions of the causes’ action since the conditions can also be considered as causes and the "bad infinity" of the changing conditions that follow will take place exactly as it does in the case of a chain of causes.

The link to the infinity of the connections of the material world also does not work, because, firstly, although these connections are huge in number, they are not infinite; and secondly, it is not clear why the connections themselves change if the same causes under the same conditions generate the same effects even if there were any number of them. No changes in the world would have been possible were

they not themselves changing. Links to changing connections also lead to "bad infinity". The idea of development, self-change, evolution in this case is absolutely impossible. At best, circular logic emerges in the reasoning: changes in the world occur because the cause-effect relationships change, whose change in turn exists because the world changes. In general, this is a tautology.

The link to the intersection of cause-effect connections is also untenable, since it is not clear why, when intersecting completely in a precise, regular and constant way, they nevertheless lead to different results, and, as a result, to evolution in nature. In addition, it is necessary to explain where the intersection of causes itself comes from. That is, we again come to the "bad infinity".

I believe that Laplacian determinism has so far been misunderstood. With the help of regular unchanging cause-effect relationships, it is impossible to obtain a regular, but changing mechanical world. In other words, the deterministic world of Laplace cannot develop and, consequently, exist in general if the same causes under the same conditions lead to the same effects.

In order for the deterministic Laplacian world to exist, it is necessary that the same causes under the same conditions lead to unequal, but nevertheless, logical effects. I understand how weird this idea sounds! This is even more so since I cannot show any evidence. I will only say that I understand that the phrases "the same", "under the same" are not trivial. Or, more correctly, they can be given a non- trivial meaning.

Attempts to modernize Laplacian determinism for some reason always came down somehow to introduce randomness into it, and moreover this randomness was also introduced in a regular way. I will not get involved in the discussion associated with the concept of "randomness" until it is clarified just what is hidden under the concepts of the cause-effect relationship and Laplacian determinism in its classical expression. I suppose that in the concept of cause-effect relationships we are not considering some important element; moreover, we do not even suspect its existence.

Albert Einstein devoted several of his works to the problem of causality in the special theory of relativity. From them it follows that the conclusion about the impossibility of superluminal speeds is motivated only by its link to experience, that is, to the observational fact that in our world the cause always precedes the effect. The special theory of relativity does not at all by itself prohibit superluminal velocities and, thereby, a temporal reversal of the cause-effect chain. Furthermore, superluminal velocities quite naturally and logically follow from STR, and that means that it even allows time reversal. It is not difficult to observe that in the acceptance about the cause-effect connection and the limit of the speed of light there is another incident of circular logic. Indeed, from acceptance that in all inertial reference frames the temporal sequence of cause and effect (retarded causality) persists, it follows that the action’s velocity cannot exceed the speed of light. Conversely, from acceptance that physical actions cannot propagate at a speed greater than the speed of light, it necessarily follows that of the temporal reference frame.

The principle of causality in its retarded form is a type of third postulate of the special theory of relativity, but its choice for the adjustment of STR with the physical reality known to us, from a nomological point of view, is arbitrary.

Again, we must make a disappointing conclusion that the principle of causality is unable to substantiate the direction and irreversibility of time due to the presence of circular logic in reasoning. Furthermore, the principle of causality in its "retarded" version still has no nomological substantiation, but is only an empirical fact. The existence of "advanced" causality does not contradict any of the laws of physics. And from the principle "the same causes under the same conditions lead to the same effects," it follows that the strictly deterministic world of Laplace in its modern interpretation cannot exist.

Chapter four

THERMODYNAMIC ARROW OF TIME

“If something comes into being and is destroyed, then it does so either at the time in which it exists or at the time in which it does not exist. If it happens at some time, then it neither comes into being nor is it destroyed; since it exists, it does not come into being and nor is it not destroyed. But nothing of it can be experienced in which time it does not exist, because then nothing happens, and in that this “something” that does not exist can neither act nor be acted upon. And generally if this is so, nothing comes into being, nor is it destroyed.”

Sextus Empiricus. “Two books against physicists” [«Две книги против физиков»]

We have the last stronghold left—thermodynamics. Almost none of the physicists and philosophers doubt that the cause for the flow of time’s direction and its irreversibility is placed right here. If you heat any part of a macroscopic body, and then separate by thermal insulation the body from its environment, then the body temperature will gradually equalize. In such processes, the explicit direction, the one-sidedness of something (believed to be time) plays an important role. The second law of thermodynamics, as formulated by Rudolf Clausius, reflects the most characteristic features of such processes. It is considered that from the second law of thermodynamics for such systems it follows that a certain function exists called entropy that increases monotonically until it reaches its maximum value in the state of thermodynamic equilibrium. One may also generalize Clausius's formulation to systems that exchange energy and matter with the outside world. On this basis, it is argued that irreversible processes lead to a kind of one-sidedness of time: the second law of thermodynamics associates the positive direction of time with an increase in entropy.

But so far, this is only an experimental fact. Yes, time in our world does flow from the past to the future. Yes, it has been experimentally confirmed that the entropy of closed systems is increasing. But it does not follow from this that an increase in entropy is the cause of the positive direction of the passage of time. There is a clear correlation between them, but not dependence!

Ludwig Boltzmann, the first to discover the value of entropy as a measure of molecular chaos, came to the conclusion that the law of increasing entropy is a reflection of increasing disorder.

In classical mechanics, the state of a system of point particles is usually described by coordinates and momenta. Of particular importance is the energy of the system, recorded in these variables, called the *Hamiltonian function*, or *Hamiltonian*. It is

believed that the motion of the system is fully determined if the Hamiltonian is known. The laws of classical dynamics, expressed in the language of Hamiltonian equations, are based on the law of conservation of energy and the condition of invariance, which, however, are one and the same thing. The law of conservation of energy, in turn, is based on the position that time is homogeneous, or on the position that there are inertial systems, the proposed existence of which, as we have seen, is based on ***circular logic***.

To establish a connection between dynamics and thermodynamics, Josiah Gibbs introduced the concept of a *representative* ensemble, the main idea of which, instead of consisting of one dynamical system, it consists of many systems corresponding to the same Hamiltonian. If the initial conditions are uniquely defined, then the ensemble is concentrated in some region of the phase space with a clearly distinguishable boundary. If, however, the initial conditions allow a certain arbitrariness, then the ensemble is distributed over a wide area of the phase space with a blurred boundary. This “cloud” can be considered a continuous medium with a certain density. The change in density in any element of the phase space volume occurs due to the difference between the flows entering this element and leaving it through the boundary. It is believed that the flow in the phase space has a remarkable feature—it is incompressible, that is, the volume in the phase space is preserved in time. From this condition, a simple equation of motion for the density of the flow in phase space is derived. This is the well-known Liouville equation. But the Liouville equation, like the wave equations of dynamics, has two solutions. Usually one is accepted, which ultimately leads to the claim that the entropy in a closed system increases. But this is a completely arbitrary choice. The second solution would lead to a decrease in entropy, but it is discarded being as how it does not correspond to reality. Since we are looking for the cause of asymmetry in thermodynamics, it is no longer possible for us to refer to thermodynamics itself. And in this case, we do not have any external or internal asymmetry to choose any one Liouville solution. And we are forced to take both decisions together, and their sum, obviously, is zero. That is, there are no ensembles, streams, and stream densities. The choice of the needed solution, I repeat, is nomologically arbitrary. After all, we want to find out *why* entropy is increasing, and not just agree with this fact as experienced.

The idea that such a thermodynamic equilibrium is easiest to obtain if we assume that in a state of thermodynamic equilibrium the density distribution becomes constant on the energy surface. This was precisely what Gibbs's basic idea consisted of. Gibbs called the corresponding distribution the *microcanonical* ensemble. It is believed that Gibbs was able to show that the assumptions made by him follow equilibrium thermodynamics’ beginnings. In addition to the microcanonical ensemble, Gibbs introduced other ensembles, for example, the *canonical* ensemble corresponding to systems in contact with a large reservoir of energy at a constant temperature.

The canonical transformation allows us to speak of clearly identified bodies or particles, since the potential energy (a certain fraction of the energy "between" the bodies) in this case is excluded and we are talking about the total energy of the system. Such systems are called *integrable* dynamics systems. But Henri Poincare

showed that most of the most interesting problems of classical dynamics, starting with the three-body problem, cannot be reduced to integrable systems. In a sense, this marked the end of classical dynamics. In general, if physical systems belong to the class of integrable systems, then they cannot “forget” their initial conditions. The distribution function never becomes constant on the microcanonical surface corresponding to a given value of energy. The final state in this case very significantly depends on the previous history of the systems, and such a concept as approaching the equilibrium state loses its meaning. That is, *the transition from the dynamics of integrable systems to thermodynamics is impossible*.

These difficulties led James Clerk Maxwell and Ludwig Boltzmann to introduce the assumption of the existence of *ergodic* systems. In an ergodic system, the phase fluid spreads over the entire available phase space on the microcanonical surface, but, as is usually believed, the volume element retains its shape. There are far more complex types of flows in the phase space also possible. The phase liquid not only spreads over the entire phase volume, but the phase volume is strongly deformed, producing amoeba-shaped projections in all directions and, after a sufficiently long period of time, the distribution becomes uniform regardless of what its initial shape was. Such systems are known as mixing systems. Any two points, no matter how small the distance between them at an initial moment of time, can diverge as far as necessary.

There are flows having even more complex properties than the mixing ones. These are *K-flows*, whose properties are especially close to the properties of stochastic systems. In the transition from ergodic flows to mixing flows and, further, to K-flows, the motion in the phase space becomes more and more unpredictable.

Ergodic systems are essentially based on the Liouville equation. And in this case, as well as for integrable systems, if you do not introduce any asymmetry in advance by volitional force, in the end we get a zero solution. That is, if we rely on the Liouville equation in its symmetric form, then no ergodic systems exist. I don’t at all want to say, of course, that these systems do not exist in nature; I just want to draw attention to the fact that if we choose the second, “meaningless” solution of the Liouville equation, we could just as well state that in the ergodic system, the phase fluid, initially spreading over the phase space on the microcanonical surface, sooner or later converges into its volume element, whereupon this element will decrease. But, I repeat, the nomological criterion for the selection is not yet known to us. But we can argue that *there is no transition from the dynamics of ergodic systems to thermodynamics*, just as in the case of integrable systems.

The formulation of the second law of thermodynamics, from the point of view of a modern physicist, is more of a program than an assertion allowing an unambiguous interpretation, since neither William Thomson nor Rudolf Clausius specified the exact formula letting the change in entropy be expressed in terms of observational quantities. The lack of clarity in the formulation of the second law was, apparently, one of the reasons for the application of thermodynamics quickly becoming limited to the equilibrium (final) state of thermodynamic evolution.

The Boltzmann probability distribution gives the basic principle governing the structure of equilibrium states. It is called the Boltzmann order principle. Even in classical physics there are quite a few phenomena in which a non-equilibrium state can generate order. Having created a temperature gradient in a mixture of two different gases, we will observe an increase in the concentration of one gas at the hot wall and the other at the cold wall. The idea that non-equilibrium can be a source of order served as the starting point for the development of the Brussels school, headed by Ilya Prigogine.

All this is true, but with one significant question: where does the non-equilibrium come from? While it is introduced arbitrarily, without any justification, its presence relies only on observational facts. Conventionally, one can call the version of thermodynamics that we have in physics “retarded”. It is equally logical, then, to develop an “advanced” version of thermodynamics in which the entropy in a closed system will decrease.

To make the transformation from equilibrium to a non-equilibrium state, it is necessary to calculate the production of entropy in an explicit form. In physics, this is done very simply, assuming that outside of equilibrium, entropy depends on the same variables as in the equilibrium state. But each time, asymmetry is postulated, not deduced. Considering the symmetrical reversal of speeds and forces in dynamics, we can completely legitimately get the production of so-called *negentropy*, i.e., order. And the existence of *dissipative* structures that violate symmetry still remains mysterious. The main evidence usually adds up to the following: beyond the thermodynamic equilibrium of the system, dissipative structures, i.e., fluctuations, can be generated, and macroscopic fluctuations can lead to new types of instabilities. That is, in the reasoning here, *circular logic* is obviously present.

Nevertheless, the approach developed by Ludwig Boltzmann was amazingly successful and left a deep imprint on the entire history of physics, although it encountered serious difficulties. Henri Poincare discussed in detail the connection between the second law of thermodynamics and classical dynamics. His conclusion was categorical: *thermodynamics and dynamics are incompatible*. Earlier, he had proved that in the framework of Hamiltonian dynamics there is no coordinate and momentum function that would possess the properties of the Lyapunov function. Poincare’s conclusion remains valid even within the framework of ensemble theory.

Thus, the so-called Poincare-Misra theory leaves us with only two alternatives; we can, following Poincare, conclude that a dynamic interpretation of the second law does not exist. Then irreversibility results from some additional phenomenological or subjectivist assumptions—from “mistakes”. But how in this case can we take into account the enormous number of important results and concepts that follow from the second law of thermodynamics?

Ilya Prigogine follows another path. Poincare tried to match the entropy with a certain function of coordinates and momenta, but his attempt ended in failure. But Ilya Prigogine considers whether it is possible to preserve the idea of such an introduction of a microscopic entropy wherein the macroscopic entropy would be a

suitable average from the microscopic one. Thus, according to Prigogine's thinking, we might be able to implement the Poincare program in a different direction. In quantum mechanics, the operators are compared to physical quantities. In an approach using ensembles, the evolution in time is described by the Liouville operator. The thought arises of trying to implement the Poincare program in terms of an operator corresponding to the macroscopic entropy (or the Lyapunov function).

As a result, Ilya Prigogine creates a chain, which, in his opinion, leads from the laws of dynamics, invariant concerning the reversal of time, to a description of nature incorporating a designated direction of time. And by the mechanism that violates the invariance of the dynamic description concerning time reversal, the second law of thermodynamics is proven. In fact, Ilya Prigogine himself recognizes the presence of ***circular logic*** in his reasoning. In his book *From Being to Becoming* [available in English, ISBN 0716711079] [«От существующего к возникающему»] he writes: "After we supplemented the dynamics with the Lyapunov function, past and future became different, as they are in macroscopic thermodynamics, where the future corresponds to a greater value of entropy. But here one needs to be careful. We can construct the Lyapunov function, which will increase monotonically with the passage of time, but we can construct another Lyapunov function that will decrease monotonically. In a more technical language, the transition from a situation... corresponding to a dynamic group to a situation .. corresponding to a half-group can be completed with two paths: in one case, equilibrium is achieved in the "future", in the other case, in the "past". In other words, one can violate the temporal symmetry of dynamics in two ways, between which they are difficult to differentiate." [Here and elsewhere, translated from the Russian edition, ***not*** quoted from the English one.]

So what then did Ilya Prigogine achieve?

The difference between the past and the future is, in his opinion, a primal notion preceding scientific activity. It can only be learned from experience. How?! That means then, goodbye to the nomological explanation of the "process" and the irreversibility of time!

"As a fundamental physical fact, we accepted," writes Ilya Prigogine, "the law of entropy's increase and the existence of the 'arrow of time' resulting from it. We see the task of a satisfactory theory of irreversibility in studying those fundamentally important changes in the conceptual structure of dynamics to which the adoption of the second law of thermodynamics leads as the main postulate."

And it's not necessary to do anything in this case, because then in dynamics, whether it is mechanics, quantum mechanics, electrodynamics, etc., we accept retarded potentials, retarded action, retarded causality without explanations, and physics remains as it already is. But **why** in a closed system does entropy increase and time flow from past to future; in this case we will never know.

It is interesting to take note of the historical analogy that Ilya Prigogine cites. This analogy is still useful to us. Before the appearance of Einstein's special theory of relativity, several attempts were made to explain the negative result of the Michelson-Morley experiment. The authors of theories dealing with the constancy of the speed of light tried to explain the constancy as the apparent effect caused by the genuine contraction of the measuring rods moving relative to the ether. Explanations have been proposed linking the contraction to the electromagnetic interaction of charged particles forming the measuring rod. Einstein proceeded differently; he took the constancy of the speed of light as a fundamental physical fact and observed what changes in our notions about space, time and dynamics would lead to the adoption of such a postulate.

Further, Ilya Prigogine writes: “In a similar way, we proceed when not trying to explain the second law of thermodynamics as an apparent property associated with one or another approximation (or introduced by the dynamics of one or another ‘unknown’). We postulate the second principle as a fundamental physical fact and are trying clarify what changes in our notions about space, time and dynamics would lead to the adoption of such a postulate.”

I notice only one thing. If Einstein, postulating the constancy of the speed of light, thereby postulated a certain symmetry, then Ilya Prigogine, accepting the second law of thermodynamics as a fundamental fact, thereby postulates a certain significant asymmetry, not having specifically given any evidence supporting the selection of this asymmetry.

And here is what we get as a result. “The question of what can and cannot be realized physically is empirical. The advantage of our formulation of the second law is that it establishes the interconnection between the second law of thermodynamics and the ‘arrow of time’ defined by it, with a limitation (at a fundamental level) on the preparation of the initial conditions of certain types. It is interesting to note that in physically interesting models of dynamical systems, the types of initial conditions, excluding a symmetry by a process that is contravening,,, coincide exactly with those that on an intuitive level are never perceived as realizable."

And this is all? That the second law of thermodynamics is an empirical fact, I already knew before. But I was interested to know what lies behind this fact? Why does entropy increase in our world? And the thought of Ilya Prigogine can be formulated as follows: entropy in closed systems increases because it has been empirically established that it increases in closed systems. Such a formulation does not suit me.

Ilya Prigogine emphasizes, “Entropy gives us the principle of sampling. By its nature, this principle is new. It cannot be deduced from dynamics. It limits the class of functions that can be observed or prepared ... On the contrary, there is every reason to expect that the second law of thermodynamics is valid only for those systems in which there are states that convert to the forbidden with the reversal of time.”

First, "Entropy gives us the principle of sampling … It limits the class of functions that can be observed or prepared," and then, this principle of sampling "is valid only for those systems in which there are states that convert to the forbidden with the reversal of time." Is it really not obvious that this is clearly ***circular logic*** in reasoning?!

And the last quote: "... From the existence of time-oriented laws, such as increasing entropy towards the future, the existence of time-oriented states in this kind of system follows."

This is a tautology!

And yet, Ilya Prigogine's book *From Being to Becoming* [«От существующего к возникающему»] is one of the most interesting books on physics that I have read. The problem in it is surprisingly clearly formulated although the author's very attempt to deduce the direction and irreversibility of time from the time-symmetric relationships of thermodynamics were unsuccessful. It is clear that this is impossible if one does not introduce any asymmetry in advance. But such asymmetries in modern physics no longer exist.

We are faced with a tragic fact**. All the dynamic equations of physics, the causality principle, the thermodynamic inequalities are symmetric with respect to time reversal; and in this case we must take the sum of two mutually exclusive solutions. But then our world simply does not exist; respectively, there is no space, there is no time.** It is a very depressing picture.

Chapter five

VARIATION PRINCIPLES, SYMMETRIES, CONSERVATION LAWS

“Things are annihilated back into the very elements from which they arose, in accordance with their intended purpose; they pay [the elements] their rightful due for any loss after a fixed period of time*.”*

Anaximander.

A certain kind of object is considered symmetric if after certain operations on it (for example, rotation, translation, etc.) it looks exactly the same as it was before the operation. In theoretical physics, the concept of symmetry is carried over into physical laws. Symmetry is understood as the invariance of physical laws with respect to some transformation of the quantities included in these laws.

In many cases, the invariance of laws is reduced to their symmetry. For example, mirror symmetry is the invariance of laws regarding the replacement of right by left. CPT symmetry [Charge, Parity, Time Reversal symmetry] is the invariance of laws regarding the exchange of a particle with an antiparticle; the shift of its position from right to left; and time reversal, etc.

Geometric principles of invariance are closely related to classical conservation laws, and dynamic principles play a decisive role in the structure of conservation laws that obey the objects of the microworld.

It is considered that up until now not a single occurrence has been discovered in which any of the classical conservation laws would be violated.

Symmetries have a direct relationship to the properties of space and time.

The *homogeneity* of space implies the absence of exclusive reference points. In other words, any point in space can be taken as the origin of the inertial coordinate system, and the course of the physical law for it will not change from this. It is the property of space homogeneity that determines the equivalence of inertial reference systems.

Isotropy of space implies that there are no preferred exclusive directions in space. Thus, for instance, when moving from any point in space in any direction, the body does not gain any advantages in any of them: neither in the speed of movement, nor in energy, nor in anything else.

The *homogeneity* of time implies that the course of physical processes does not depend on the setting of the initial and final moments of time.

In modern physics, *variational* principles have great significance, especially the *principle of least action*. Joseph-Louis Lagrange was the first to consider the conservation laws of energy, momentum and angular momentum as integrals of differential equations in dynamics. William Hamilton gave a new form to this principle. He proposed considering the integral being present in the principle of least action upon its calculation as a function of its limits. Introducing a quantity called the system's *Hamiltonian*, equal to the difference between the kinetic and potential energies, he derived his canonical equations for generalized coordinates and generalized momenta.

Max Planck believed that with the general principle of all reversible processes the *principle of least action* appeared, which underlies the construction of a unified physical picture of the world, since it includes four world coordinates perfectly symmetrically and is invariant with all Lorentz transformations. Planck showed that the principle of least action applies to both electrodynamics and thermodynamics.

From the principles of least action of Hamilton and Lagrange it follows that if space and time are homogeneous and isotropic, then free motion will always appear as motion with constant speed, that is, the law of inertia will be fulfilled. Thus, the existence of inertial systems in nature is a direct consequence of the special properties of space and time. The identification of these properties is given above, but we still do not know yet just what exactly makes possible the existence in nature of homogeneity of space and time and isotropy of space. If space and time did not possess these properties, then inertial frames of reference would not exist. In addition, we must remember the unresolved *circular logic* in reasoning when trying to infer the principle of inertia.

Emmy Noether provided a general algorithm allowing one to find a complete system of invariants for any physical theory formulated in terms of the Lagrangian and Hamiltonian formalism. The content of *Noether's theorem*, in essence, consists in the assertion that for any continuous transformation of coordinates that converts the action's variation to zero, when the transformation law is also specified, there corresponds a certain invariant, that is, some conserved quantity composed of the corresponding functions and derivatives. And since the transformation is closely connected to the properties of space and time, that last statement implies that each property of space and time, expressed in the covariance of differential equations with respect to a certain group of transformations, must conform to a certain law of conservation.

The invariance of the Lagrangian with respect to time displacements (homogeneity of time) corresponds to the conservation law of energy; invariance of the Lagrangian with respect to spatial rotations (isotropy of space) is the conservation law of angular momentum; invariance of the Lagrangian with respect to the displacements of the original state is the law of conservation of momentum.

The connection between the conservation law of energy and the homogeneity of time implies that the passage of time by itself cannot cause a change in the physical states of some closed system. Changes can occur only at the expense of a specific amount of energy. In other words, the continuous growth or a mere change in a closed system in time is impossible precisely because of the persistence of the conservation law. The connection between the conservation law of momentum with the properties of space homogeneity implies that a closed system’s movement is not enough for a change to its state. That is, without interaction with other systems, a closed system does not change its state. The connection between the conservation law of angular momentum with the properties of isotropy of space implies that the rotation of a closed system in space does not change the mechanical properties of the system.

In the presence of dynamical symmetries in a system, that is, associated not with space and time, but rather with a certain type of interaction, Noether's theorem also allows finding the corresponding conserved quantities. In just this way the conservation law of electric charge can generally be substantiated.

The problem of the origin of phenomena symmetry and conservation laws in the world around us does not yet have a scientific solution that is convincing.

The conservation laws of energy, momentum, angular momentum, charge, and other attributes are considered to be exact and universal principles underlying all physics. There is an attempt to explain the origin of the properties of symmetry on the basis of these laws. However, according to Noether's direct theorem, conservation laws are derived from the properties of symmetry. Attempts are also being made to derive the properties of space and time from conservation laws. Extensive literature exists on this topic.

Taken as a whole, the conservation laws in physics assert the invariability of the quantitative values of some physical quantities in any process. If one abstracts from the whole variety of specific conservation laws, then we come to the generalized principle of conservation, which is expressed by the principle of causality in relation to isolated systems: “cause is equal to action” (effect). In the conservation law of energy, this aspect is the most important and constitutes the most characteristic feature of all conservation laws. But then we return to the difficulties to which the principle of causality leads. Analyzing the conservation law of energy, Max Planck wrote: “That comparatively extraordinary speed and ease with which a law of such tremendous importance as the conservation law of energy, after the overcoming of the first difficulties, became the achievement of the minds, not only is explained by numerous individual inductive proofs, but also in large part by, the idea of its intrinsic connection with the law of cause and effect”.

The connection between the conservation law of energy, extremality and causality in Hamilton's principle of least action is especially important for physics. The formulation of this principle asserts that of all possible motions of the system, for which the action extremum is realized, that motion is realized in which there is no violation of conservation laws. In fact, the principle of least action is one of the possible expressions of the conservation law.

We can say that the variational principles are based on the condition of invariance, conservation laws and the principle of causality. But we can also say that conservation laws are based on variational principles, conditions of invariance, and causality. And it is possible this way: the conditions of invariance are based on variational principles, conservation laws and causality. And even: causality is based on the condition of invariance, variational principles and the conservation laws. The fact is that all these four statements are tautologies and are based on the position that there are inertial systems, that is, on *circular logic*.

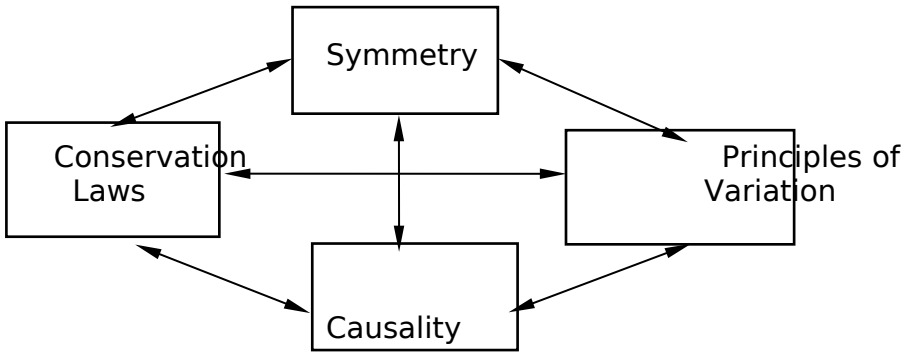

Fig. 1.

Associated with the principle of symmetry, invariance suggests the immutability of the laws of nature. The conservation laws suggest the immutability of certain physical quantities. Causality is determined by the parity (equivalence) of cause and effect. Variational principles are based on the extremeness of the action, which

implies the immutability of the action. Thus, in this *circular logic* there is no room for change.

The validity of variational principles, symmetries, conservation laws and the principle of causality is maintained only for inertial systems, which, in turn, requires homogeneity of space and time and isotropy of space. What these characteristics consist of, we have already found out. But in what way can we verify that these characteristics actually take place?

We have only one single way to be sure of this—by measuring the speed of light in a vacuum. If it is constant at different points in time, then time is homogeneous; if it is constant at different points in space, then space is homogeneous; if it is constant in different directions of space, then space is isotropic. It is known that the special theory of relativity affirms just this, and numerous experiments confirm it.

But here is what is interesting. As we clarified in the previous chapters, the claim about the existence of inertial systems, and, consequently, about the constancy of the speed of light, encounters insurmountable difficulties. Namely: in this case, the solutions to all dynamic equations and thermodynamic inequalities equal zero, that is to say, our world does not exist. While it is true that in this case there are conservation laws that exist; however, but there *is* nothing to conserve.

It turns out to be a strange picture. On the one hand, physics unconditionally recognizes the constancy of the speed of light in a vacuum, the existence of inertial systems and geometric symmetries. But in this world nothing happens.

On the other hand, a fact, completely reliable by experiment, the presence in our world of *retarded* solutions for the wave equations of mechanics and electrodynamics, *retarded* causality and an *increase in entropy* in a closed system arises. But with this (it's scary to say!), apparently, there are no inertial systems, variational principles are incorrect, conservation laws are "not conserved", symmetries are violated and the speed of light in a vacuum changes. But, as we are used to, time *flows* from the past to the future.

Moreover, the third option is theoretically possible, when the world has advanced solutions of wave dynamic equations, advanced causality, and the entropy in closed systems decreases. Time flows from the future to the past. But with this some other global violation of symmetries occurs and there are no conservation laws; however, it is better to say that they (conservation laws) change in some way. Here the speed of light also changes, but somehow it does so differently than it does in our world. For example, in our world it decreases, but in the time-reversed world it increases.

What then should we choose? A symmetrical world that doesn’t exist, or an asymmetrical one that does?

In this work, I will not talk about the breaking of some symmetries in the theory of elementary particles, about the breaking of the energy-momentum conservation law in the general theory of relativity, and about spontaneous symmetry breaking

somewhere, at the very beginning of the existence of our Universe. But here's what I want to say: **all symmetries must be broken.** Physics cannot do without this. But breaking stereotypes in physics occurs slowly, with difficulty, where it becomes already self-evident.

It is much more natural to assume that global and constant breaking of all symmetries occurs in the world. Mathematically, this means that the Hamiltonian (and the Hamiltonian operator) is not invariant under all transformations. The physical embodiment of this non-invariance of the Hamiltonian will be the inconstancy of the speed of light, of the fundamental interaction.

Of course, this sounds crazy, but when I talk about the inconstancy of the speed of light, I am not referring at all to the trivial meaning of these words.

But, it seems, physics has no other way of overcoming the numerous difficulties.

Chapter six

SPECIAL THEORY OF RELATIVITY

“The law cannot be precise, if only because the concepts with which we formulate it may develop and in the future prove to be insufficient. At the bottom of any thesis, traces of the dogma of infallibility remain.”

Albert Einstein. "About Science" [«О науке»]

Albert Einstein's special theory of relativity is based on two postulates: the principle of relativity and the principle of the constancy of the speed of light, formulated in the 1905 article "On the Electrodynamics of Moving Bodies" as follows:

"1. The laws for which the states of physical systems change do not depend on which of the two coordinate systems [i.e., frames of reference], moving uniformly and rectilinearly relative to each other, these changes apply.

2. Each ray of light moves in a "resting" coordinate system with a limiting speed *c*, regardless of whether the ray of light is emitted by a stationary body or a moving one.”

Both principles are fundamental.

The problem of experimental verification of SRT is considered, in essence, solved and, in any case, it is not relevant. Modern physics, or rather, modern physicists, are not entirely friendly to any attempts to revise the foundations of SRT.

Intuitively, the first postulate seems quite understandable and logical. Indeed, why should the laws by which the states of physical systems change on our Earth differ from the laws that operate in some distant galaxy? So far, we cannot name any such reasons.

In order to obtain some information about the state of a physical system remote at some distance, we have only one means to do it: light (an electromagnetic field).

Виктор Колупаев «Пространство и время для фантаста»

Until the beginning of the 20th century, the theory of light propagation was based on the concept of a luminiferous medium - the ether, which, as they thought then, transmitted light oscillations. From Fizeau's experiment in 1851, it followed that the ether is not entrained by matter, that is, there is a movement of the luminiferous medium relative to matter and vice versa. But since the luminiferous ether was, according to those concepts, something uniform, primal in relation to light and moving in the most diverse directions of matter, it was quite logical to assume that the ether was motionless.

Hendrik Lorentz's hypothesis about the ether at rest, singled out from all unaccelerated moving systems, a system with a certain state of motion, namely, one that is at rest relative to this luminiferous medium. Therefore, absolute motion exists, since there is one distinguished state, namely, one at rest relative to the ether. In this case, we can call the body absolutely at rest in the sense that it is at rest relative to the luminiferous medium. Reference systems, at rest relative to the ether, differ from all other non-accelerated systems. In this sense, Lorentz's basic ideas about the ether at rest contradicted the principle of relativity. The motion of the reference system with respect to the ether should have an impact on the laws of nature operating in this system. Since, for example, the Earth revolves in an orbit around the Sun, it then, together with our laboratories, could not in the course of a year remain at rest relative to the ether. It was necessary to find some phenomenon in which the influence of this movement on experiments would be manifested, since in this way our physical space that we have on earth, must, because of this relative motion, have different properties in different directions. However, nothing of the kind was found in a single experiment. In short, if there is an ether, then the laws, according to which the states of physical systems change, depend on which of the two coordinate systems moving uniformly and rectilinearly relative to each other, these changes relate to. That is, in order to prove the first postulate of SRT, it is necessary to prove that no motionless ether exists. And vice versa, based on the situation that no motionless ether exists, it can be argued that all inertial systems are equivalent.

The most famous of all experiments for detecting the existence of the ether (or ethereal wind) was the Michelson-Morley experiment of 1887, which determined the speed of light in various directions. The speed of light appeared to be the same. To explain the negative result of this experiment, Lorentz proposed a hypothesis about a shrinking of the length of the body in the direction of movement. It turned out that the speed of light in different directions can be different, but the lengths of the measuring rulers change to the same exact degree and that likewise the rate of the clock speed changes, which always leads to the same result: the measured speed of light always remains constant. Lorentz tried to determine the physical mechanism of the process for the change of the length of the body and the rate of the clock speed, but the level of knowledge of that time about the structure of matter did not allow him to create a flawless theory. However, the attempt to explain the fact of the constancy of the speed of light by the peculiarities of the behavior of material systems in itself was extremely important.

Einstein approached the problem differently. He postulated the principle of relativity, simply having rejected the hypothesis of the existence of the ether.

Further, by having defined the concepts of space, time, and especially simultaneity, Einstein arrived at the same transformation equations, known as Lorentz transformations. The path that Einstein followed was simpler, clearer; he did not require knowledge about the structure of matter. By the way, Ilya Prigogine did the same thing, having postulated an increase in entropy in a closed system. Lorenz's attempt turned out to be more cumbersome and less conclusive.

The most heated discussions were caused by the second postulate, which was in obvious contradiction with the classical rule for adding velocities. Attempts were made to construct theories consistent with experience, in which the principle of relativity would be preserved, and the second postulate would be replaced. The proposal of the dependence of the speed of light on the movement of the source was introduced in 1908 by Walter Ritz. According to this assumption, the speed of light in vacuum is constant only with respect to the source. If the light source moves at a certain speed relative to any frame of reference, then the speed of light in this system consists of the speed of the source and the speed of light, as happens with the speed of a projectile when firing from a moving gun. This hypothesis is called "ballistic". But [this hypothesis] did not make any substantial progress.

It is interesting to consider the question of whether Einstein used any additional assumptions when constructing SRT. There are several such assumptions noted in the article “On the Electrodynamics of Moving Bodies” [«К электродинамике движущихся тел»] by Einstein himself:

1. "At point B, the same time can (or should) exist as measured at point A." This is a requirement for the homogeneity of space.

2. "The time required for light to travel from A to B is equal to the time required for light to travel from B to A." This is the requirement for the isotropy of space.

3. "The presence of solids in nature," we mean, of course, absolutely rigid bodies.

4. "When an absolutely rigid body is transported along the x-axis, its length does not change." This is a requirement for the homogeneity of space.

5. "Space has the property of homogeneity."

In the 1907 paper "On the Principle of Relativity and Its Consequences" [«О принципе относительности и его следствиях»], Einstein introduces the requirement for the homogeneity of time.

Thus, as postulates of the two preceding main ones of SRT, the requirements of homogeneity and isotropy of space and time are used. And only then, on their basis, are postulates about the principle of relativity and the constancy of the speed of light from a moving source introduced. We observed a similar picture with Newton’s attempt to introduce the concept of an inertial frame. Introducing the requirement of homogeneity and isotropy of space and time, Einstein thereby requires the constancy of the speed of light in inertial frames, and then claims that the speed of

light is constant in different inertial frames (principle of relativity). But this is obviously ***circular logic***.

The second postulate is essentially only a weaker formulation of the first postulate, despite their seeming incompatibility. If the light source moves uniformly, then it is an inertial frame of reference; therefore, the speed of light emitted by it, for the receiving frame, which is also an inertial one, will be constant due to the presence of the same ***circular logic***. Moreover, it makes absolutely no difference whether the source, the receiver, or both are moving. If the source moves with acceleration, the picture becomes much more complicated. But then the source does not move in the inertial frame, and this case has nothing to do with SRT.

Hence, the foundations and postulates of SRT can be reduced to one phrase: the speed of light in vacuum is constant if the speed of light in vacuum is constant. This is a tautology.

Let's ask a simple question: what is the speed of light in general? In his 1917 paper “On the Special and General Theory of Relativity” [«О специальной и общей теории относительности»].Einstein answered it thus: “There is hardly a simpler law in physics than that according to which light propagates in empty space. Every schoolboy knows, or at least thinks he knows, that light propagates in a straight line at a speed of 300,000 km/sec.”

The simplicity of the concept of "speed of light" for Einstein is obvious here. But this is only at first glance. Both earlier and later, Einstein thought deeply about this strange concept. In some ordinary sense, it really does not represent anything mysterious. But any deep analysis immediately meets with great difficulties. Speed is a relative concept. For example, the speed of a car or train is relative to the Earth. However, the speed of light somehow does not agree with this concept of relativity. What is the speed of light relative to?

When determining the speed of light according to the usual formula: the speed is equal to the distance divided by the time, we meet with serious difficulties. Henri Poincaré drew attention to one of them in his book *The Value of Science*, [«Ценность науки»] published in 1905, it is difficult to separate the qualitative problem of simultaneity from the quantitative problem of measuring time; it makes no difference whether we use a chronometer or take into account the speed of transmission, for example, the speed of light, because it is impossible to measure speed without measuring time.

The presence of circular logic in the definition of the speed of light was pointed out by many authors. In order to determine the value of the speed of light, it is necessary to know the distance that light travels and the time it takes light to travel this distance. And in order to determine time, one needs to know the speed of light and distance. Similarly, with the definition of distance, one needs to know the propagation time and speed.

Einstein was fully aware of the difficulties in determining the speed of light. Jean Piaget, in his lecture “The Place of Psychology in the System of Sciences,” [«Место психологии в системе наук»] said: “Einstein believed... that in physics these concepts form a vicious circle: speed is determined using time and space, and time, in turn, is measured by speed.”

Samuel Lilley has similar reasoning in the book *Discovering Relativity for Yourself:* [«Теория относительности для всех»] “Some concern could be caused by the following reasoning, by which it looks like a vicious circle: to decide what should be understood by the words “moment of time and distance to a distant event”, we used the properties of speed light, even though we didn't know anything about speed until we determined what a moment in time and the distance to a distant event were. But now I think it is clear that in reality such definitions were introduced that gave confidence in advance that the conclusion about the invariance of the speed of light in all cases would follow from them. We had to take such precautions, because the choice of definitions leading to any other conclusion would give a completely unusable theory, since it would contradict one of the most fundamental principles of the real world.

It is interesting to note that many authors at first express the idea that ***circular logic*** is embedded in determining the speed of propagation of light in vacuum, but then a conclusion is made about the need for such logic, since leaving it, its breakup would allegedly lead to some unpleasant difficulties in physical theory. But, strangely enough, for some reason none of them shows any desire to analyze the reason for the appearance of this ***circular logic***, and even more so, to break it.

On the contrary, there are attempts to justify the existence of such logic. In this case, they usually refer to geometry. From the definition of a square, one can deduce the equality of its diagonals and the fact that they intersect at right angles, dividing each other in half. But vice versa is also possible from these assumptions to determine the square. But the whole point is that there is indeed ***circular logic*** in the definition of a square. And it was torn apart only after the development of non-Euclidean geometries, that is, after the introduction of some internal asymmetry into the geometry.

So, we can assume that **Einstein's special theory of relativity is internally contradictory. In its foundation remain conditions that still need to be proven.** Until now, it has not been possible to give a satisfactory definition of the concept of the speed of light.

It is interesting to review how all the experiments performed to date for determining the speed of light prove its constancy. Are there not any circular logic or other pitfalls here, which can shatter the generally accepted claim about the constancy of the speed of light?

Chapter seven

EXPERIMENTAL DETERMINATION OF CONSTANCY OF THE SPEED OF LIGHT

“A concept can never be deduced from experience in an irreproachable way. But for didactic as well as heuristic purposes, such a procedure is unavoidable. Moral: if you do not sin against logic, then you can’t come up with anything at all.”

Albert Einstein. From a letter to Maurice Solovine.

Physicists did not have any particular doubts about the constancy of the speed of light, especially after Michelson's experiments and the establishment of the special theory of relativity.

For determining the speed of light, it is necessary to measure the distance that light travels and the time it takes light to travel this distance. Or, in other words, we need to measure length and duration. The use of the concepts of length and duration makes sense only if there is an idea of their ideal standards. But real standards should be able to be realized.

Up until 1960, the international standard of the meter was a linear measure of length—a bar of platinum-iridium alloy, stored at the International Bureau of Weights and Measures in Sèvres (near Paris). The meter is equal to 1/40,000,000 of the Parisian meridian, adopted on December 10, 1799, as the standard of length.

Initially, a second was accepted as a time interval equal to 1/86,400 of a mean solar day. This definition had a significant drawback, since the length of the solar day is increasing. In 1956, 1/31,556,925.9747 of the tropical year, which is equal to the time interval between two identical positions of the Earth relative to the stars, was accepted as a unit of time—a second. However, the time interval of the tropical year also varies, so the interval of the tropical year 1900 was accepted as the standard. The inconvenience was that the ephemeris time was always determined retroactively from astronomical observations.

According to Albert Einstein’s view, which he expressed in the 1936 article "Physics and Reality" [«Физика и реальность»], the concept of time is preceded by the concept of a periodic process, and the concept of space is preceded by the concept of a solid (or quasi-solid) body. From a number of his articles it is clear that SRT is built on the assumption of the existence of absolutely rigid bodies and ideal clocks. The reliance on these two definitions, in Einstein’s view, made it psychologically possible to create not only the special, but also the general, theory of relativity.

Some physicists have repeatedly pointed out the inconsistency of the concept of an absolutely rigid body. Einstein himself in the 1923 article "Basic Ideas and Problems of the Theory of Relativity" [«Основные идеи и проблемы теории относительности»] wrote: "... it seems logically unjustified for the whole physical consideration to precede the concept of an absolutely rigid body (or simply solid), and then, ultimately, to build it (the body) beforehand on an atomistic foundation, based on the primary physical laws, which, in turn, are themselves constructed using the concept of an absolutely rigid body. We mention these methodological shortcomings because they are inherent in the same sense in the theory of relativity in its schematic representation, which we present here. Of course, it would be logically more consistent to start with the essence of the physical laws themselves and only to this essence to present the ‘requirement of meaningfulness’, i.e., to take to the very end the establishment of an unambiguous connection with the world of experience, instead of implementing it in an imperfect form already for one artificially isolated part of the theory, namely, for the space-time metric. However, we have not yet advanced far enough in the establishment of the primary laws of nature in order to take this more perfect path without risking losing the solid ground under our feet.”

That is, Einstein, of course, was very much aware of the presence of circular logic in the reasoning about the measuring of the speed of light, based on the concept of an absolutely rigid (or simply rigid) body and an ideal clock.

In his 1949 Autobiographical Notes, [«Автобиографических заметках»] he wrote: “Let us now make a critical observation about the theory as characterized above. It can be seen that the theory introduces (besides the four-dimensional space): 1) scales and clocks, 2) everything else, such as an electromagnetic field, a material point, etc. This is in a certain sense illogical; strictly speaking, the theory of scales and clocks should be derived from the solutions of the basic equations (considering that these objects have an atomic structure and they move), and should not be considered independent of them.”

It sometimes seems to me that Albert Einstein at that time was close to some kind of serious reassessment of the meaning of the special theory of relativity. But something prevented him from doing this: the undoubted successes of SRT, old age, death? I don't know. And I will never know.

What property must a “practically” solid body have in order to make a standard of length out of it? This property, according to Einstein, is one of the greatest possible immutability, the constancy of the dimensions of the body, regardless of any external conditions.

Practically solid bodies, which can be used for the creation of practical standards of length and duration, consist of atoms and molecules. Solid bodies are possible because between atoms and molecules (as well as in the atomic structures themselves) there are interatomic and intermolecular interactions, which are electromagnetic interactions. Atoms and molecules, as it is known, have their own periods of oscillation, and substances are called solid in which, due to certain periods of oscillation of atoms, the same distance between atoms is maintained

regardless of the shape of the object made of these substances (for example, a standard of length). Therefore, it can be claimed that in fact the length of the standard is determined by the oscillation period of the atoms that make up this rod, and the value of this period is translated into the language of length using the speed of light.

If we (with good reason) believe that the distance between atoms in so-called rigid bodies corresponds to the periods of oscillation of these atoms, then we can say that these distances are determined by a radiolocating method [i.e., a laser].

With this approach, the length of a solid body (standard) depends on the speed of electromagnetic interaction in the atom itself as well as between atoms. The lower the speed of this interaction, the greater the length of the body and the slower the pace of the clock (for example, a pendulum).

The radiolocating method leads to results consistent with conventional methods of measuring. Usually we measure distance with a rigid measuring ruler. At first glance, it seems that when both ways lead to a single result, then this is additional proof of the constancy of the speed of light. In fact, this is not so. Since maintaining an unchanged distance between atoms is essentially carried out in accordance with the radiolocating method, measuring the speed of light using a rigid ruler does not provide an alternative method of measuring, but only a more complex version of the way, requiring the use of billions of radiolocation installations instead of one.

But now the assertion that the speed of light is constant loses all of its basis. Velocity is distance traveled divided by time, but we have no way to measure distance other than radiolocation, wherein it’s already assumed that the speed of light is constant.

Again, this is ***circular logic***. But now it is clear what it is based on. It is based on the fact that *we measure the speed of light by comparing it with the same speed of light*. It seems as if I were to measure my height with my own height, and I had no other methods of measurement. And although it is clear that my height is changing, I could, with good reason, say that it remains constant all the time. But in the case of measuring the height of a person, we still have other ways, but in the case of measuring the speed of light, there are no other ways to measure it.

That is, if the speed of light were to change for any reason, then it would still remain a constant speed for us.

Thus, the speed of light is different from all other speeds in the world. There is nothing to compare it with, except itself.

And now I can declare that all the experiments set up for proving the constancy of the speed of light using the standards of length and duration are a delusion. In reality, what was investigated in these experiments is the stability of atoms.

I am now omitting some subtleties related to the fact that the speed of electromagnetic interaction in matter is less than the speed of light in a vacuum and is different for different substances. This does not influence my conclusions.

The speed of light can be determined in another way. To do this, one needs to know the wavelength and frequency of the electromagnetic field. The speed of light will be equal to the product of these two quantities. The first experiment of this kind was carried out by Heinrich Hertz in the eighties of the nineteenth century. The experiments were not distinguished with much accuracy, and he did not set such a goal for himself. But one thing he noted correctly: in order to measure the speed of light, the wavelength and its frequency must be determined from some independent processes. He measured the wavelength as the distance between two adjacent antinodes of a standing wave, and calculated the frequency from the values of the inductance and capacitance of the vibrating source of the waves.

Knowing the geometric dimensions of the vibrating source, this measuring is easy for someone to do. At that time, Hertz could not yet know that when measuring the distance between two antinodes of standing waves, he used length standards based on the electromagnetic interaction, that is, that the determining of the speed of propagation of electromagnetic waves in this way already contains *circular logic*. With changes in the speed of light, the frequency and duration of the wave would change such that the speed of the electromagnetic interaction would remain the same.

In 1960 a new length standard was adopted. They decided to associate the new unit with some “natural” measure taken from nature. The length of the electromagnetic wave turned out to be convenient for these purposes. According to the new definition, the meter is equal to 1,650,763.73 wavelengths of radiation in a vacuum corresponding to the transition between two specific levels of the krypton-86 atom. A new definition of the second was adopted in 1967. This standard is a transition between two specific ultra-thin levels of the cesium-133 atom, which is not disturbed by external fields. And the frequency of this transition is determined as the value 9,192,631,770 Hertz.

So, now both standards—in both length and duration—are taken explicitly from the electromagnetic process. And this obviously means that the definition of the speed of light no longer makes sense, since previously the standards are connected through the speed of light. The ***circular logic*** here is so obvious that it has been repeatedly noted by many physicists. Suggestions have been made that the spectral line [i.e., lines appearing in a displayed spectrum, often used to identify the presence of atoms or molecules] should be used for determining frequency or [wave]length, but not both together. Unfortunately, there is essentially no other way for determining the frequency and wavelength. Of course, the frequency ranges in which the length and duration standards are determined are different. But these ranges still refer to electromagnetic radiation. And the speed of propagation of electromagnetic waves in a vacuum for all of the ranges is the same.

The most accomplished methods for determination of the speed of light come down to the comparison of the emission lengths of a laser and krypton-86 atoms and the emission frequency of the same laser and cesium-133 atoms.

So what was measured when they increased the accuracy of measurement of the speed of light? The answer is obvious: the stability of the light source.

The 1983 XVII General Conference on Weights and Measures established the following definition of the meter: a meter is the distance traveled in vacuum by a planar electromagnetic wave in 1/299,792,458 of a second. With this definition, the value of the speed of light is adopted as a value equal to 299,792.458 km/s and not subject to refinement.

It is considered that there are no indications of change in the speed of light over time. But here's what I wanted to point out. It is not worthwhile to think that with the help of experiments it will be possible to prove the constancy or change in the speed of light over time. The idea that the speed of light is not constant in a trivial sense (it was, for example, 300,000 km / s, but it became 250,000 km / s) is meaningless. *The speed of light is not constant in a non-trivial sense. It changes, remaining the same all the time .*

We will now turn to experiments for determining the speed of light from a moving source. A schematic diagram of such an experiment is shown in Fig. 2.

Light from a moving source S is absorbed by plate B (prism, mirror, etc.) and re-emitted towards A [not shown]. But upon absorption and re-emission (reflection, refraction, diffraction), the light beam loses information about its speed and propagates further at a speed *c*. More precisely, another ray propagates from B to A at a speed *c* from stationary source B. To verify this, we must compare in some way the speed of light in the section l with the speed of light in the same section from the obviously stationary source with respect to A of source S^1.

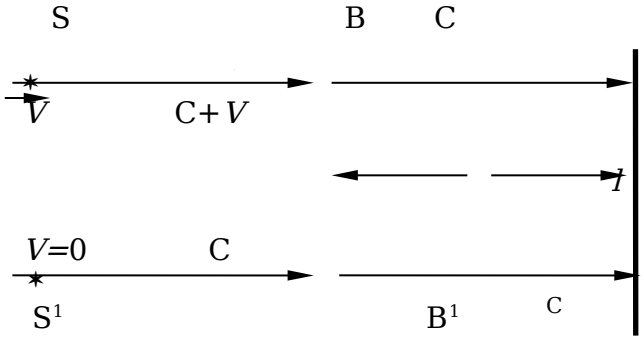

Fig. 2.

It is clear that no additional effects will be found in this situation. The speed of light from a moving and stationary source will be the same. This situation will be observed both for moving celestial light sources and for moving or stationary terrestrial sources. This, in fact, is exactly what all experiments on determining the speed of light from a moving source show, since in the end it always is not the speed of light from a moving source that is measured, but rather the speed of light in the section l, where it should be constant. In other words, no matter how hard we try to determine the speed of light from a moving source, each time we determine the speed of light from a light source at rest relative to the observer! That is, not a single experiment for determining the speed of light from a moving source has demonstrated the correctness of the second postulate of SRT. All of them were simply incorrect.

It is necessary to give a brief analysis of the experiments for determining the ethereal wind (the influence of the Earth's motion on the speed of light), which, ultimately, led to the development of Albert Einstein's special theory of relativity. I will not be concerned with the experiments of the first order and will go straight to the experiments of the second order, or more precisely, to the most famous of them —the Michelson-Morley experiment of 1887. Michelson first developed an apparatus —an interferometer, the working principle of which is well known. Briefly, the essence of its action is that the beam of light is split into two, which move along mutually perpendicular paths and then the split beams converge. An interference pattern of alternating dark and light bands is obtained. They set one arm of the interferometer in the direction of the Earth's motion; they fix the resulting picture. And then the apparatus is rotated 90 degrees and they fix the resulting picture again. If there is an immovable ether, then the speed of light in the first and second cases will be different, which the apparatus should fix due to the shift of the interference bands. No band shift within the measurement error limits was found.

In 1892, George Fitzgerald and Hendrik Lorentz, independently of each other, proposed a hypothesis that makes it possible to combine the result of the Michelson-Morley experiment and the existence of the ether. The essence of this hypothesis was that the motion of the Earth relative to the ether can affect the magnitude of the forces of molecular interaction, and through them, the length of bodies. The length of any body (including the arm of the interferometer) in the direction of motion decreases relative to its true magnitude in such a way that it completely eliminates the possible effect of a change in the speed of light.

Виктор Колупаев «Пространство и время для фантаста»

In his 1895 work “Michelson's Interference Experiment” [«Интерференционный опыт Майкельсона»], Lorentz wrote: “However strange a given hypothesis may seem at first glance, it must nevertheless be recognized that it is not at all so unacceptable, if only we assume that molecular forces are transmitted through the ether, just as we can now certainly argue the same about the electric and magnetic forces. If that is so, then it is very likely that translational motion will change the interaction between two molecules or atoms in the same way as the attraction and repulsion between charged particles. Since the shape and dimensions of a solid object are ultimately caused by the intensity of molecular interactions, then a change in dimensions in this case cannot occur. Therefore, from the theoretical point of view, there cannot be any objections to this hypothesis.

... Desiring to detect such small quantities, one can perhaps hope for success only with the help of the interference method ... Repeating the previous reasoning, we can now say that the shift resulting from the change in lengths is compensated by the Maxwellian shift.

Lorentz at that time still could not know that the "molecular" forces are in fact "electric and magnetic" forces. But he came surprisingly close to the explanation to the adverse results of the Michelson-Morley experiments. The fact is that if the speed of the measured light changes, then the speed of electromagnetic interaction in the material of the interferometer arm changes exactly to the same degree, and as a result of comparing these two identical speeds, we make the conclusion that the speed of light does not change. Hence, Lorenz's explanation was, in principle, correct.

Einstein went in a different direction. If no experiments lead to the discovery of the ether, then there isn’t any, and hence, there is no predominant coordinate system. And since the optical and electrodynamic laws are now valid for all coordinate systems moving uniformly, then the speed of light in all these coordinate systems is identical and, furthermore, does not depend on the speed of the source. In other words, what Fitzgerald and Lorentz tried to explain, Einstein postulated. Lorentz considered that the speed of light could be unstable, but this could not be verified experimentally. Nevertheless, Lorentz did not doubt the existence of the ether, and Einstein, on the basis of his postulate, abandoned it. And if physics in the end, perhaps quite rightly, abandoned the ether, as it once abandoned the caloric, then the matter with the constancy of the speed of light was more complicated. It is impossible experimentally to prove the constancy of the speed of light. And there is indirect experimental evidence of a change in the speed of light, to which we will proceed shortly.

In a major 1907 work, “On the Principle of Relativity and Its Properties” [«О принципе относительности и его свойствах»], Einstein wrote of Lorentz's proposition: "...this hypothesis, brought ad hoc, seems to be nothing more than an artificial means of saving the theory...". And in the work of 1910 “The Principle of Relativity and its Consequences in Modern Physics” [«Принцип относительности и его следствия в современной физике»]: “... this hypothesis destroyed the differences between theories and experimentation. However, this theory did not represent a single whole thing. It was based on the existence of the ether, which

had to be considered as moving relative to the Earth, whereby the consequences of this movement could never be detected experimentally. Such a strange property of the theory could only be explained by introducing a priori unlikely hypotheses. Can one really think that, because of a curious accident, the laws of nature appear to us in such an unusual way that not one of them makes it possible to study the rapid movement of our planet through the ether? Wouldn't it be more plausible to assume that some erroneous consideration led us into a dead end?”

Thus, Einstein's special theory of relativity finally put an end to the incorrect concept of "light-carrying ether", as well as the problem of the constancy of the speed of light. After Einstein, few people were interested in what would occur in nature if the speed of light were not constant?

And yet, the indisputable advantage of Lorentz's theory was that, when interpreting the Michelson-Morley experiments, it tried to take into account the behavior of a material object having an atomic structure. And if at the end of the 19th century it was still impossible to say how the length of the material body and the pace of the material clock change, by the 30s of the 20th century this could and should have been done.

So, what do all of the experiments on measuring the speed of light and the detection of the ethereal "wind" show? For some reason, it is still considered that they irrefutably prove the constancy of the speed of light in all possible implications. But as we found out, this is not the case.

Experiments prove only the fact that with any change in the speed of light, in fact, in these experiments it will seem constant. Since the speed of light can only be measured by comparing it with the same speed of light, it is identical with itself. No matter how the speed of light changes, experimentally it will always be 300,000 km/s.

In the fifth chapter, we found out that if the speed of light is constant, then any variation of the world is equal to zero and the world simply cannot exist. This conclusion came into conflict with the traditional conclusions and experimental demonstrations of the special theory of relativity. Now we see that this contradiction no longer exists. The special theory of relativity does not at all prove the constancy of the speed of light; it only postulates it illegally.

Chapter eight

A NEW DEFINITION OF SPACE AND TIME

(Interpretation and consequences)

“There was a true Light that enlightens every person who comes into the world. It was in the world, and the world came into being through [the Light], and the world did not recognize It.”

"From the Holy Gospel of John". [«От Иоанна Святое Благовествование»]

8.1. A proposed idea.

I present the following proposal:

The world (the Universe) can exist only if the speed of light in a vacuum changes.

The speed of light in a vacuum changes while remaining equal to 300,000 km/s under all experimental determinations.

Naturally, at least one fact is needed to confirm this.

Let’s assume that the speed of light in a vacuum decreases. We will denote such a speed as c. What will we discover in doing so? A decrease in the speed of light would mean that all the linear dimensions of bodies increase proportionally, and the pace of the clock would slow down.

If there is an increase in dimensions of bodies (and the gaps within them increase) and the slowing down of the clock rates are caused by a decrease in the speed of light, and if we explore this world with the help of light, which has a finite and also decreasing speed of propagation, then the Universe will appear before us as an expanding Universe.

It is precisely the expansion of the Universe, being that indirect fact that indicates that the speed of light in our world is decreasing, while yet naturally remaining equal to 300,000 km/s in all experiments.

Виктор Колупаев «Пространство и время для фантаста»

In 1929, Edwin Hubble discovered the redshift in the spectra of distant galaxies, which is interpreted as the effect of the recession of galaxies. The relative rate of change in distances is called the Hubble constant or parameter. In our time, its value lies in the range of 50 - 100 km / s / Mpc [i.e., Megaparsecs].

It is believed that the phenomenon of recession, or expansion of the Universe, refers only to the distances between galaxies, and the distances between stars in galaxies, and especially that the sizes of stars and planets themselves do not change in time. Here, for example, is what Igor Novikov writes in the book “The Evolution of the Universe” (3rd edition) [«Эволюция Вселенной» (издание 3-е)]: “Sometimes one hears the statement that, as a result of the expansion of the Universe, everything in the world expands: not only do galaxies scatter, but the galaxies themselves expand, individual stars expand, our Earth,too, in general, all bodies expand. This, of course, is not true. The recession of galaxies does not affect individual bodies in any way... Just as individual molecules do not expand in an expanding gas cloud, so in the expanding Universe, gravitationally bound bodies—galaxies, stars, the Earth—are not subject to cosmological expansion. (An even stronger statement can be made: if absolutely all objects, including atoms, expanded in proportion to their size, then the expansion would be unobservable. Indeed, then there would be no unchanging standard in relation to which the expansion is measured). Of course, they can expand and contract, but this is caused by internal factors—processes that occur inside the bodies.”

First, Igor Novikov is mistaken when he claims that “if absolutely all bodies would expand in proportion to their sizes”, then “the expansion would be unobservable”. The author implicitly assumes that the study of such a world will take place with the help of processes that have an infinite propagation speed. And second, he does not connect the reason for the very increase in the sizes of bodies and the slowing down of the rate of the flow of time to be in a change in the speed of light, understanding the Big Bang in the literal sense: “Galaxies are now moving by inertia and their speed is inhibited by gravity ...”.

I believe that the recession of galaxies is due to the global decrease in the speed of light, c; that is that as the speed of electromagnetic interaction decreases between galaxies, so does it likewise decrease inside an atom, molecule, and between atoms and molecules. Of course, the speed of electromagnetic interaction in matter is less than it is in a vacuum; that is, the possible expansion of galaxies, star systems, stars and planets should be proportionally less than the Hubble constant, but a qualitative picture is important for us now.

A simple calculation shows that the speed of the expansion of galaxies is several kilometers per second. But the detection of such speeds of expansion of galaxies by modern means is unlikely.

In the mid-1960s, experiments were devised for the measurement of the time it would take for a signal sent from Earth to reach some planet, bounce off it, and return back to Earth. As the experiments of the Irwin Shapiro’s group showed, such a delay in the signal reflected by Mercury was actually observed. This delay was explained by the action of the gravitational field of the Sun.

Experiments were carried out by the radar of a space-based apparatus in which a significant delay of radio waves was revealed, which was interpreted as an influence on the passage of electromagnetic waves of interplanetary plasma.

Lunar radar has shown that the semi-major axis of the Moon's orbit is increasing by 3 cm per year. The Moon’s moving away from the Earth has been known for a long time and is usually explained by tidal tension.

Science is well aware of the deceleration of the Earth's rotation around the Sun and around its own axis.

Currently, a number of scientists studying the Earth think that the Earth is expanding in its evolution. For example, Masao Gorai's book "The Evolution of the Expanding Earth" [«Эволюция расширяющейся Земли»] is devoted to this problem. According to the author: “The question of the physical mechanism and reason for the expansion of the Earth seems to be most difficult and almost insoluble. Therefore, it remains for one only to express probable proposals.”

To solve this problem, Gorai mainly relies on geological phenomena: the transition of the metal phase to oxide and silicate: it is that, which leads to an increase in the volume of matter, etc. But the author does not eliminate the reasons for the expansion of the Earth that probably need to be sought not only inside the Earth, but also in space. He has in mind the problem of cosmological expansion.

It makes no sense here to describe in detail the evolution of the expansion of the Earth, due to a decrease in the speed of electromagnetic interaction. This is the business of scientists who study the Earth. I want to point out just one subtlety. If the speed of this interaction, on average, in the rocks that make up the earth's crust is greater than the same speed in the matter supporting the earth's crust, then this supporting matter will expand faster than the crust, and thereby produce pressure on it, which will lead to a rupture of the crust. in its thinnest places, and consequentially lead to the spreading of the continents. The area occupied by ancient rocks will increase proportionately less than the total surface area of the earthly globe.

Radar experiments have shown that the continents are indeed moving away from each other.

Vitaly Melnikov and A. G. Radynov in the article “Influence of cosmological expansion on local processes in the solar system” [«Влияние космологического расширения на локальные процессы в Солнечной системе»] write: “When assessing the possible influence of the cosmological evolution of the Universe on local processes, it is natural to assume that the relative rate of change of any value with time is characterized by the Hubble parameter H, the significance of which in the modern time period is H_0 equal to 5×10^{-15} / years. The smallness of H_0 makes difficult the detection by experiment the influence of cosmology on local processes under terrestrial (laboratory) conditions.”

An experiment could be done by placing radar stations on different continents and measuring their distance from each other. The estimated lengthening of the earth's circumference is approximately 2-3 mm per year. It is fully possible that such an amount could be determined experimentally.

8.2. Interpretations of the "red" shift.

So, if the expansion of the Universe is due to a decrease in the speed of electromagnetic interaction, then outwardly it will look like a simple removal of objects from each other with speeds that are greater, the greater is the distance between the objects. As they like to say, galaxies fly apart and the "red" shift in their spectra is interpreted as an ordinary Doppler effect. This can be called a **space-time** explanation of the "red" shift.

Let’s suppose that the mass of any particle, such as an electron, was less at the moment when a photon was emitted by a distant galaxy than the mass of the same particle in our time. According to quantum theory, when there are other equal conditions, the wavelength of the spectral line of examination that occurs with the moving of an electron from one energy level to another, its energy changes inversely with the mass of the electron. Then a photon emitted by an electron of a distant galaxy has a longer wavelength than a photon born in our time, only because it was born when the masses of elementary particles were less than they are now.

In the article of 1907 "On the principle of relativity and its consequences" [«О принципе относительности и его следствиях»] Albert Einstein predicted the gravitational frequency shift and provided its approximate formula.

The explanation for the gravitational shift was as follows. Einstein postulated complete physical equality (for all physical phenomena) of a system at rest in a uniform gravitational field and a system moving uniformly accelerated in the absence of gravity. This is the so-called principle of equivalence. Using this heuristic principle, Einstein replaced the study of physical processes in a uniform gravitational field with their study in a uniformly accelerated system in the absence of gravity. Einstein based it on the fact that if at some instant the simultaneous readings of two local clocks coincide, then at the next instant this simultaneous coincidence will be violated. Applying the Lorentz transformations to two readings of the local clock, separated by a time interval (according to the clock originally set), Einstein came up with the gravitational formula for the frequency shift.

In the 1911 article "On the Influence of Gravity’s Force on the Propagation of Light" [«О влиянии силы тяжести на распространение света»], Einstein provides a new justification for gravitational shift using the Doppler effect in a uniformly accelerated system in the absence of gravity. At the moment of emission of light, the speed of the source and the receiver are the same, i.e., their relative speed is equal to zero. But for overcoming the distance between the source and the receiver,

it takes time. And during this time, the speed of the receiver due to acceleration will change. Thus, the speed of the source at the moment of signal emission and the speed of the receiver at the moment of signal reception differ by some amount, as a result of which the Doppler effect should occur. On account of the principle of equivalence, that same effect must take place in a uniform gravitational field.

In an article of 1907, Albert Einstein erroneously specified: “It can be said that the process occurring in the clock, and in general any physical process, proceeds the faster, the greater the gravitational potential in the area where this process is playing out.”

In the 1916 article "Fundamentals of the General Theory of Relativity" [«Основы общей теории относительности»], Einstein writes: "So clocks run slower if they are set near substantial masses. From this, it follows that the spectral lines of light coming to us from the surface of large stars should shift to the red end of the spectrum.

Thus, as Einstein believed, gravitational shift is a question of frame of reference. The course of the clock (the rate of the flow of time) depends on the gravitational potential of that place where the clock is located. Therefore, quantities that depend on the frame of reference, such as energy, mass, momentum, duration, frequency, and others, having one value in the source frame, have a different value in the receiver frame, if there is a difference in the gravitational potential between the source and the receiver.

Here we note that Einstein's list was missing length.

Einstein was forced to admit that the speed of light is not constant near gravitational masses: the smaller it is, the greater the gravitational mass itself is. But here we need to stop and comprehend this statement of Albert Einstein. The whole thing here is that, in the gravitational field, not only the rate of the flow of time changes, but length also does. And if we conduct an experiment for determining the speed of light, we will be surprised to find that the speed of light is still 300,000 km/s.

No experiments are possible to prove that the speed of light is different from 300,000 km/s. In a gravitational field, the standards of length and duration change in such a way (after all, their value depends precisely on the speed of light) that this value will remain constant. Although it is quite obvious that if the standards of length and duration did not change, then we would get some other value for the speed of light. That is to say, we again come to the conclusion that **the speed of light (this time in a gravitational field) changes, remaining numerically equal again to 300,000 km/s.**

At that time they had no idea about the expansion of the Universe. And when this fact became generally recognized, for some reason no one applied the principle of equivalence and did not express the notion about it, that if the speed of light near

gravitational masses decreases, then the speed of light from any receding source should also decrease.

The matter here is that one can only measure the speed of light "here-now". We scrutinized this case in the seventh chapter. A person located near the gravitational mass can also measure this speed in the region, which for him is the region of the "here-now". It will be equal to 300,000 km/s. A person in a galaxy receding from us with a great speed, after measuring the speed of light, will also come to the conclusion that the speed of light in the region that is for him the “here-now” region is 300,000 km/s.

But, since these different standards of length and duration are used, I can declare that the speed of light, from my "here-now" point of view, in the second and third cases is $\mathbf{n_1}c$ and $\mathbf{n_2}c$, respectively. The point (or region) "here-now" is a dedicated frame of reference, which, however, can be declared by any other observer who is at his own point (or region) "here-now".

The same can be said about the speed of light (the speed of the fundamental interaction) in regard to the relation "here-now", of the "here-then". The speed of light "here-then" in relation to the speed of light "here-now" is equal to $\mathbf{n_3}c$.

In our Universe, the speed of the fundamental interaction (taking into account only the expansion of the Universe) "here-then" and "there-then" is greater than the speed of this interaction "here-now".

I only ask you to realize that the speed of light, for example, "here-then" is not 1,000,000 km/s, but $\mathbf{n}c$.

And yet, I still do not endorse the expressions "speed of the fundamental interaction" and "speed of light", but I will do it soon.

8.3. Relational-subjective definition of space and time.

Now we need to reflect on what is the constancy and at the same time the inconsistency of the speed of light. It is obvious that these properties of the speed of light refer somehow to two different levels of the description of the world. Using the ideas of Immanuel Kant, I am expressing the following state: **at the level of things in themselves (noumena), the speed of light changes, and there it has no size, but it simply changes several times; but at the level of appearance for a thing to be a perceiving subject (phenomenon), the speed of light is constant and equal to 300,000 km/s.**

In his work “Last Thoughts” [«Последние мысли»], Henri Poincaré wrote: “Until now, we have not asked the question of whether laws actually change, we only

asked whether people can believe that laws change. But are the laws themselves immutable in themselves, if we consider them as existing outside the mind that created or observed them? Not only can we not solve such a question, but it does not make any sense. Why should we ask ourselves whether laws can change with time in a world of things-in-themselves, if in such a world the concept of time itself may not make any sense? About what this world presents itself as, we can neither say nor think anything, we can only talk about how it appears to a mind, not too different from ours.

Let’s imagine that there is a certain world consisting of four points A, B, D, I, between which there is an interaction with a constant speed *c*.

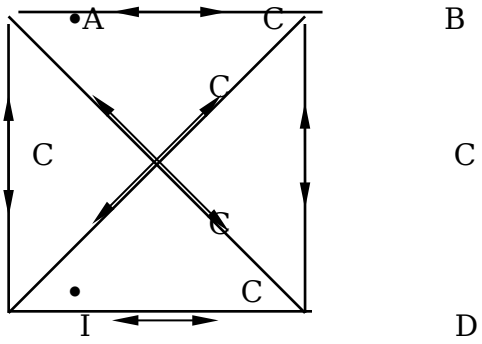

Fig. 3.

Points A, B, D, I are depicted not on a plane, but in some configuration space of the speed of light. The fact is that I (like any person) don’t have a way to depict the configuration space in any other way than in the generally accepted one, usually for us as space (volume, planar surface). But let's remember that A, B, D, I are not actually depicted on a plane. And AB, BD, DI, IA, AD and BI are not distances.

So, in some configuration space there are four points, the interaction between them which occurs at a constant speed. In order to investigate this world, a perceiving subject is needed. It may be protested to me that this world A, B, D, I exists even without a perceiving subject. I agree. But the world that exists by itself (noumenon, thing in itself) differs from the world perceived by a subject (phenomenon).

Let’s imagine further I is the perceiving subject "I". What can "I" say about the world A, B, D, I? Nothing! Again, it may be protested to me that something can still be said: for example, that these points still exist (this includes “I”), that the distances between these points do not change, that the time required for the passage of

signals from A, B, D, to “I” also does not change. But I categorically object to this, and here's the reason. You just can't escape from the fact that these points still exist in space. No, they exist in the configuration space of the speed of light. But it is not the same. In order to measure the distance, if any, from “I” to A, “I” must send a signal (beam of light, photon) from I to A and detect the time of the sending of this signal, and then receive the re-radiated signal and again detect the time. But for this “I” must have memory. I do not know what memory is, but I can still name one property of it: **there must be some kind of change in me. as a necessary condition for my memory.** But since nothing fundamentally changes in the world of A, B, D, I, “I” cannot have a memory and, thereby, measure the distance of IB. Furthermore, “I” cannot even imagine that A, B, D exist. “I” will monotonously emit photons not even knowing it, because it has no mechanism to know that it has already emitted or is emitting a photon. In just the same way, “I” cannot know that it has previously received photons from A, B, D.

In other words, if the speed of the interaction in the system A, B, D, I is constant (and inside “I”, too), then “I” in no way can know that A, B, D exist, and that “I” itself exists too. That is, if at the level of the thing-in-itself the world A, B, D, I exists (although, as we will see below, such an assumption cannot be made), then, **in principle**, nothing can be said about it. Furthermore, as a phenomenon, that is, as a world for the perceiving subject, this world does not exist, and therefore does not have any attributes, in particular, such as space and time.

Now let's imagine a "supernatural" case, when “I” has memory and consciousness. This is precisely the case that Immanuel Kant speaks of as the a priori nature of space and time. That is, these concepts are inherent, pre-experienced for a creature with memory and consciousness. Let's see how the world A, B, D now appears to the conscious “I”. The speed of the interaction between A, B, D and “I” continues to remain constant. Now “I” can say that there exists an external world from which “I” receives signals. What else? And that's everything. There is nothing else!

“I” cannot even know that the “outer world” A, B, D consists of three points, since the signals from them are no different from each other. “I” can regularly send signals in a "direction" (no directions in this world exist), for example, to B, and just as regularly receive signals emitted by B. “I” has no way to "mark" its signals in order to determine the time it takes them to reach B and return back. Only the same exact signals can come from “I” to B as from B to “I”. And even if “I” were able to "mark" its signals, again in some "supernatural" way, then in the signal received from B, this information would still be absent, since B would still send to “I” its own signals. In other words, “I” would not be able to determine that B is at any distance from “I”. The concept of external space, as before, could not have arisen. But not only a concept that can be constructed, but space itself in general cannot be determined without regard to my “I”. There is no space in this case, just as there is no time.

Let's make one more "supernatural" assumption. Let’s imagine that “I” can still send some marked signals to A, B, D. A, B, D, in turn, will re-emit to “I” the same signals, or those marked in some other way, but understandable signals for “I”. In this case, “I” will be able to determine that the signal emitted from “I” to A and re-

radiated back comes, for example, simultaneously with the signal emitted from “I” to D and back. But the signal emitted to B and re-radiated back, for example, is delayed.

Because “I” has an a priori sense of space and time (which is still a mystery or something "supernatural"), “I” can make the conclusion that A and D are in space at the same distance from “I”, and B is at some greater distance from “I” than A and D are. And only now can we introduce the concept of external space, but only at the level of the perceived or contemplated space by me (“I”). At the level of the noumenon (thing in itself), there is no space. Space exists only for the contemplating subject “I”. For the subject, now the world A, B, D exists in space, but this is a very strange space: all distances between objects in it are constant. **It's not just a static space, it's a static world. And the pace of the clocks in it is identical. We can say about this world that it exists, but nothing changes in it, and therefore, nothing happens.** In addition, it must be remembered that we have made several "supernatural" proposals that do not follow from anywhere, but without which this static world could not be discovered, nor even exist.

It is sad, but **this is the physical reality that physics explores with the help of equations symmetric in time, which we considered above.** The cause in it is equal to the effect, and the solution of all dynamic equations is equal to zero. One can also call it a truly Lapalacian deterministic world as it really should be understood from the point of view of modern physics. All conservation laws in such a physical reality are "conserved", and the variations of the Lagrangian and Hamiltonian with respect to any transformations are equal to zero. But we must remember that even in this physical reality we cannot do without "supernatural" suppositions: the presence of memory in the subject exploring the world, and certain changes in the response signal. That is, even for the existence of this static world, certain changes are needed in it.

And if we are strictly consistent and take into account that in such a static world, the *advanced* and *retarded* actions are equal to each other, that is, they mutually cancel each other out, since we can neither introduce nor choose the boundary conditions (they are the same), then there is no (not any) interaction at a constant speed.

A static world cannot exist either at the level of the noumenon or at the level of the phenomenon.

It may seem that for no reason we have wasted time on all the previous discourses. But it is not at all so. The necessity of having a memory in the perceiving subject and certain changes in the external world in order for this world to exist, we nevertheless found out.

It is significant to note that when in the previous discourses in this paragraph I said that the speed of light is constant, I implied that it is equal to something abstract, of course, by no means the specific value "300,000 km/s". Indeed, in the world of things in themselves there are no kilometers and seconds. I hope this is clear.

But let's move on.

If at a constant speed of the interaction the world as a noumenon and the world as a phenomenon cannot exist, then it is natural to make the assumption that in the world of noumena (things in themselves) the speed of the interaction changes. Then the subject in the world of phenomena will perceive these changes as the diverging or coming closer of points A, B, D. Since in the world of things in themselves a change of speed of the interaction can, in principle, be any value (this speed is different for different objects), then the contemplating subject, having a mechanism for the perception of these changes (memory, consciousness), can now discern these changes.

I have already confessed that I do not know what memory is, and consciousness, too. To some extent, I am justified only by the fact that, apparently, no one knows this. And yet I feel it is necessary to give at least some extremely primitive definition. Not even a definition, but only a vague and, probably, unconvincing perspective to the problem. I suppose that in the human brain there is a mechanism that, according to its arbitrariness (a person’s will), changes the speed of the interaction in itself and thus brings to life the events of the past in memory. It's kind of like a pack, a bunch of speeds. In quantum mechanics, they would say the “velocity operator”. That is, as Blessed Augustine suggested, in us there is the present of the past, the present of the present and the present of the future. What’s more, this “pack” changes some of its basic interaction speed synchronously with the change in the speed of the fundamental interaction in the world of things in themselves and expands over time (the scope of the memory increases). If the basic speed of the interaction in the brain is out of sync, or the “pack” itself is somehow deformed, mixed up, then the person [with that brain], as is said, “flies off the sled,” [i.e., “loses his marbles”], “goes crazy”, and he already perceives the world of phenomena (the only one available for our contemplation) is somehow not at all the same as all other people do. What’s more, this mechanism is to some extent inherent in all systems that can distinguish at least two speeds of fundamental interaction in the world of things in themselves. Both animals and plants, and complex chemical compounds, etc., are included here, of course. This, however, is the subject of another, incomparably more complex study.

It may seem that in trying to give definitions for space and time, I myself have fallen into circular logic since any change in some sense implies the concept of time. But here it must be taken into account that **a change in the speed of the fundamental interaction at the level of the noumenon is akin to a “change” in the numbers of a digital sequence, which does not imply the presence of space and time.**

And one more thing: the idea that the knowing subject has memory is present in an explicit (or implicit) form in all scientific theories and also in physics, but in any case, it is not analyzed. So, if I have erred, then I did so no more than others.

So, Leibniz claimed that space and time are some kind of relationship between objects, “ideas of pure reason, which, however, are related to the external world

and of which we are conscious with the help of our senses. For that reason, they are allowed to have definitions and proofs.”

According to Kant, "space and time are determinations that are not at all inherent in things in themselves, but only in their relationships to sensory perceptions." In his opinion, there are two pure forms of sensual intuitions as principles of a priori knowledge: namely, space and time.

The mechanism for a priori perception of space and time is memory.

I will now try to give definitions for the concepts of space and time. This definition may seem cumbersome, but what can one do... If a short and clear definition had existed, it would have been known to people long ago.

Space and time are subjective forms of our sensory perception of objects as phenomena, consisting in the interaction between the subject, who has memory, and objects, as things in themselves, with the help of a fundamental electromagnetic interaction, the speed of which changes (for our world it decreases).

This formulation is essentially relational-subjective. From it follows that space and time can only be changing relationships and have meaning only for the subject.

In the future, I will not stipulate each time that space and time exist only at the level of the phenomenon, and the changing speed of the fundamental interaction is only at the level of the noumenon. This clutters up the presentation to a considerable degree. But it is absolutely necessary to remember this.

Space is a relation that is proportionately changing inversely with the speed of the fundamental interaction.

Time is a relation that is proportionately changing directly with the speed of the fundamental interaction.

The speed of the fundamental electromagnetic interaction (c) at the level of the noumenal world (the world of things in themselves, or objects as they are in themselves) is a concept not further analyzed. Its only property that I can claim is change.

At the level of the phenomenal world, that is, the world of objects as they appear to us, or as we perceive them, the speed of light (c) is a constant value equal to 300,000 km / s and measured in the ordinary sense of speed as it is.

As distinctive support for my reasoning, I will once again give a common example. One can say that in the world of phenomena there are colors. We perceive them perfectly if our vision is not impaired. But in the world of objects that exist as things

in themselves, there are no colors. Objects interact with each other and with us using electromagnetic fields of different frequencies. And that's all! Mankind had no idea about this for a long time. The discovery of the frequency (or wavelength) of electromagnetic radiation with the help of devices (the creation of which one can be consider as an extension of the area of sensory perception) made it possible, in a sense, to transfer the world of things in themselves into the world of appearances, i.e. phenomena. But only we must always recognize that the world of phenomena is not the same as the one in itself, but a world that we perceive or that appears to us. And to another being, possessing properties unknown to us, it would have presented itself completely differently.

So, in full agreement with Immanuel Kant, I can declare that space and time are subjective; they are only the subjective conditions of our human (or to something similar to it) intuition, and being in themselves, without a subject, they are meaningless.

And at the same time, space and time are **objective**, since all (or almost all) things as phenomena, as objects of sensory intuition are in space and time. This fundamental principle has objective truth and a priori universality. Well, what has changed? Although at the level of phenomena, space and time are still objective!

And everything has changed.

Why did I carefully express: “all (or almost all) things as phenomena”? Now I will try to explain.

Let's imagine that in Fig. 3 the speed of the fundamental interaction between A. B. D. I is equal to infinity. Then, at the level of the phenomenon, the distances between these points are equal to zero. That is, there is no space, although a flow of time exists and its speed is equal to infinity. All events in this world happen in one moment lacking any duration. If the interaction between these points happens at a speed of the fundamental interaction equal to zero, then at the level of the phenomenon there is space between any points and it is equal to infinity; and the speed of the flow of time is zero. that is, there is no time.

Let me remind you once again: if I say “the speed of the fundamental interaction” (c^*), this means that we are talking about the world of noumena, that is, things in themselves; if I say "speed of light" (c), then this means that we are talking about the world of phenomena, that is, things as they appear to us, or as we perceive them.

And now you can get five options for the world of noumena and phenomena:

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena the world does not exist at all. This is **an impossible world**.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena there is an expanding space and a decelerating speed of the flow of time. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena there is a contracting space and an increasing speed of the flow of time. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena space is equal to zero, and the speed of the flow of time equals infinity. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the space between any two points is equal to infinity, and the speed of the flow of time is equal to zero. This is **an anti-singularity**.

There are no other "pure" cases neither at the level of things-in-themselves or at the level of phenomena. "Mixed" cases can take place in any combination (with the exception of the first option).

So! I start from two postulates:

1. The speed of the fundamental interaction at the level of noumena changes. Furthermore, generally it changes however you like.

2. The subject, knowing the world, has a memory.

Both of these postulates in this theory are not further analyzed. As I have already noted, the second position, present in an implicit form in all scientific theories and in all physics, in any case is not analyzed. Yes, in fact, I need it only in order to introduce the concepts of space and time. While in quantum theory it is already difficult to do without it; in biology, psychology, sociology, etc., getting by without it is simply impossible.

It is on these two postulates that I intend to identify and briefly set forth (with significant omissions, of course) a new semantic interpretation of physical theory.

8.4. New semantic interpretation of physical theory.

Properties of space and time.

Space is not uniform. This means that all points in space are different from each other. Any point in space, taken as the reference point, is the dedicated one. This leads to the fact that the course of physical processes in it will differ from the course of physical processes in other frames of reference. But this does not lead to

any catastrophes in physics (the world of phenomena). On the contrary, the world of phenomena, as it were, comes to life. It gets the opportunity to evolve.

Space is non-isotropic. This means that the directions in space are unequal. With a change in the direction of movement, the properties of the objects change.

Time is not uniform. This means that the course of physical processes depends on the choice of the initial moment of time.

For some reason, that fact earlier did not raise surprise to anyone by the fact that space has isotropy, but time does not have that characteristic. Maybe because the introduction of time isotropy would lead to monstrous inconsistencies in physics. If time is isotropic, then the processes in the forward and reverse directions of the flow of time should not differ from each other in any way, for example, *retarded* and *advanced* actions (potentials). Physics would not be able to do this with time. The concepts of isotropy or non-isotropy of time did not seem to exist. Now, however, such a characteristic must be introduced. **Time is not isotropic.** This means that the course of physical processes depends on the choice of the direction of the flow of time.

The direction of the flow of time is given by the sign of the gradient of change in the speed of the fundamental interaction. In the case of a decrease in this speed (the gradient is positive), time "flows" from the past into the future; in the case of an increase (the gradient is negative), time flows from the future to the past.

The connectedness of space and **time** is determined by the absence of spikes in the change in the speed of the fundamental interaction.

The dimension of space is determined by the number of mutually perpendicular directions in which the speed of the fundamental interaction changes.

If this speed in all directions is infinite, then the object is a **point** (perhaps an electron). A **line** is characterized by the fact that in one of the directions the speed of the fundamental interaction is finite, but it changes, and in the other two directions it is infinite (perhaps, quarks, superstrings). If this speed in one direction is infinite, and in the other two, it is finite but having a changing magnitude, then the object will be a **plane**. And finally, if the speed of the fundamental interaction in three mutually perpendicular directions is finite and changes, then the object is a certain **volume, [a solid].**

Here it is appropriate to say a few words about the fifth postulate of Euclid's geometry. The postulate of parallel straight lines could not be proved, since it is analogous to the constancy of the speed of the fundamental interaction. Thus, it is this non-existent world that Euclid's geometry describes. And how magnificently the most diverse geometries flourished after this postulate was abandoned! The analogy with attempts to prove the constancy of the speed of light is explicit here.

Orientability of space is determined by the direction of change in the speed of the fundamental interaction. In our world space is orientable. In a time-reversed world, it is too. But these orientations are opposite. That which in our world is left, in a world whose space is determined by the increasing speed of the fundamental interaction, will be right—and vice versa.

The reversibility of time (it would be more accurate to say now: the reversibility of space and time) is quite theoretically possible. To do this, it is only necessary to reverse the direction of change in the speed of the fundamental interaction.

Variational principles, symmetries, conservation laws.

Let us first consider the question of inertial frames of reference, on which, in fact, almost all of physics is built. We remember what insurmountable difficulties there were that resulted from attempts to introduce this concept into physics in a consistent way. All these attempts turned out to be unsuccessful due to the presence of **circular logic** in the reasoning. Now, based on the postulate that the speed of the fundamental interaction cannot be constant, I can say: **there are no inertial systems.** Of course, in some specific cases, we can make an assumption about the existence of inertial reference systems and take point A, the Earth, the Solar system, or even a galaxy as such a system. But we must remember that such an assumption is arbitrary and leads to unreliable results. And only the size of the acceptable error will be the criterion for such an arbitrary assumption. In principle, I repeat, there are no inertial systems.

As was said in the fifth chapter, the content of Noether's theorem consists essentially in the claim that for any continuous transformation of coordinates reducing the variation of the action to zero when the transformation law is also given, there corresponds a certain invariant, that is, some conserved value composed of the corresponding functions and derivatives. And since the transformation is closely related to the symmetry properties of space and time, the last statement means that each property of space and time, expressed in the covariance of differential equations with respect to a certain group of transformations, must correspond to a certain conservation law.

But variational principles, symmetries and conservation laws were involved in **circular logic**. Besides that, all of them essentially were based on the concept of an inertial frame of reference, which we now consider to be an unacceptable arbitrariness. The consistent application of variational principles in their generally accepted form led to the fact that any variation of the action was equal to zero, and the world of phenomena simply could not exist.

Now, with good reason, we can consider that **any variation of the action in the world of phenomena** (that is, in the world that the only one familiar to us and which we explore) **is not equal to zero**.

The non-invariance of the Lagrangian relative to the shifting of the reference point (non-uniformity of space) corresponds to the **law of non-conservation of**

momentum; non-invariance of the Lagrangian relative to spatial rotations (non-isotropy of space), the **law of non-conservation of angular momentum**; non-invariance of the Lagrangian relative to shifts from the beginning of time,the **law of non-conservation of energy**; non-invariance of the Lagrangian relative to the rotation of time (non-isotropy of time), the **law of asymmetric reversal of all phenomena**.

The relationship between variational principles, symmetries and conservation laws (now it would be more correct to say: between the non-invariance of the Lagrangian and the Hamiltonian, asymmetries and non-conservation laws) is very simple and clear. There no longer is **circular logic**.

1. If the speed of the fundamental interaction is equal to some constant value, then variational principles are valid at the level of phenomena, conservation laws are valid as are the conservation laws, and symmetries exist. But **the world itself**, unfortunately, **does not exist in this case.**

2. If the speed of the fundamental interaction decreases, then at the level of phenomena any variation of the action is greater than zero (for example, the shortest distance between two points is greater than the “shortest” distance that we could hypothetically obtain if option “one” were implemented in the world); energy, momentum, angular momentum in a closed system decrease; symmetries are broken. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena any variation of the action is less than zero (for example, the shortest distance between two points is less than the “shortest” distance that we could hypothetically obtain if option “one” were implemented in the world); energy, momentum, angular momentum in a closed system increase; symmetries are broken. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena any variation of the action is equal to minus infinity (for example, the shortest distance between any points equal to zero); energy, momentum, angular momentum in a closed system are equal to infinity; symmetries are completely broken. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena any variation of the action is equal to plus infinity (for example, the shortest distance between any points equal to infinity); energy, momentum, angular momentum in a closed system are equal to zero; symmetries are completely broken. This is **an anti-singularity**.

Causality.

As we have shown in the third chapter, the difficulties associated with understanding causality lie in the fact that, firstly, it was not possible to explain the theoretically equal existence of *retarded* and *advanced* causality and the existence

in practice of only *retarded* causality, and secondly, it was not possible to explain the existence of changes in the world, if *the same causes under the same conditions lead to the same effects.*

Now we can remove these difficulties. Causality in the world of phenomena depends on the speed of the fundamental interaction. At the same time, which is quite understandable, the **cause-and-effect chain is non-linear**.

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena there is *complete* causality equal to the sum of the *retarded* and *advanced* causality, which is zero. Naturally, the same causes (equal to zero) lead under the same conditions (equal to zero) to the same effects (also equal to zero). This is **an impossible world**.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena there is *retarded* causality, in which the effect is less than the cause. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena there is an *advanced* causality, in which the effect is greater than the cause. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is infinite, then at the level of phenomena the effects are simultaneous with the causes, and since they are infinitely greater than the causes, we can say that in this case all possible effects take place. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the effects never occur. This is **an anti-singularity**.

"Retarded" and "advanced" potentials.

It is just as easy now to explain the existence in our world of only *retarded* potentials, and in the time-reversed world of *advanced* ones. Their presence or absence in the world of phenomena depends only on the speed of the fundamental interaction.

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena the solution of the wave equation is equal to the sum of the *retarded* and *advanced* solutions, which is zero. This is **an impossible world**.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena the solution of the wave equation will have a *retarded* appearance. Furthermore, the change in the speed of the fundamental interaction in this case no matter how small can exist. This is **our world.**

3. If the speed of the fundamental interaction increases, then at the level of phenomena the solution of the wave equation will have an *advanced* appearance.

The speed of change of the fundamental interaction in this case no matter how small can exist. This is **a time-reversed world.**

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena the solution of the wave equation is equal to infinity. Systems only emit, but do not absorb. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the solution of the wave equation is equal to minus infinity. Systems do not emit. This is **an anti-singularity**.

Entropy.

As we found out in the fourth chapter, the difficulties connected with the concept of entropy consist of the fact that it was not possible to give a nomological explanation for the increase in entropy in closed systems. Now this difficulty can be eliminated. The behavior of entropy in the world of phenomena depends on the speed of the fundamental interaction. In this case, it is necessary to make a statement that **closed systems in which entropy is a constant value do not exist.**

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena the entropy in closed systems is constant. This is **a non-existent world**.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena the entropy in closed systems increases. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena the entropy in closed systems decreases. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena the entropy in closed systems is equal to zero. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the entropy in closed systems is equal to infinity. This is **an anti-singularity**.

General summary.

Now all the basic assumptions of the physical theory can be combined into a common semantic picture (see Fig. 4).

A **strict nomological connection** exists between the assumptions (statements, laws) of each column and the speed of the fundamental interaction. Our world with its laws exists only if the speed of the fundamental interaction decreases. The time-reversed world exists if the speed of the fundamental interaction increases.

Between the assumptions (laws) of each column there is only a **strong correlation**, but there is no dependence.

To say that there is a *retarded* action in the world is like saying that in this world time flows from the past to the future, or that entropy in closed systems increases, etc. You can take any assumption from a column alone or all at once. It is precisely for the reason that among all the assumptions (columns) of the semantic picture of a physical theory there is only a strong correlation, but not a nomological dependence, and attempts to derive one from the other (for example, the direction of time from the fact of an increase in entropy in a closed system) led only to **circular logic**, i.e. to failure.

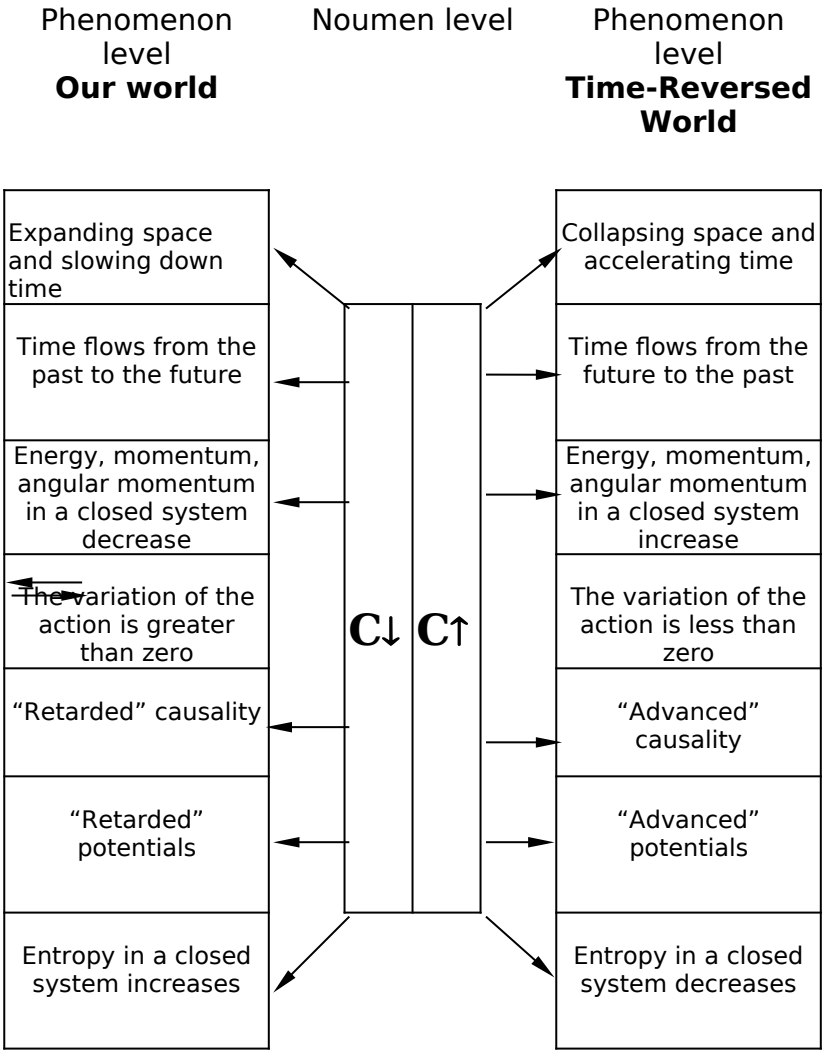
Phenomenon level
Our world
Noumen level
Phenomenon level
Time-Reversed World
Expanding space and slowing down time
Collapsing space and accelerating time
Time flows from the past to the future
Time flows from the future to the past
Energy, momentum, angular momentum in a closed system decrease
Energy, momentum, angular momentum in a closed system increase
The variation of the action is greater than zero
C↓ C↑
The variation of the action is less than zero
“Retarded” causality
“Advanced” causality
“Retarded” potentials
“Advanced” potentials
Entropy in a closed system increases
Entropy in a closed system decreases

Fig. 4

Classical mechanics.

Let's start with the problem of inertial motion. As I have already said, inertial systems do not exist, and that means there is no inertial motion. Take, for example, a plate consisting of two layers of different material. In traditional physics, this object, if no external forces act on it, will move in a straight line at a constant speed.

If the speed of the fundamental interaction decreases (as in our world), then due to the violation of the law of conservation of energy, the speed of the object will begin to slow down; due to the violation of the law of conservation of momentum, the trajectory of the object will begin to curve; due to violation of the law of conservation of angular momentum, the object will begin to rotate. Since the speed of the fundamental interaction in different substances varies in different ways, the object will begin to deform and take on some other form than it was at the moment of its “launch”. All changes in the object will be causal, but this causality is non-linear. The picture turns out to be completely different than it is in conventional classical physics and, it seems to me, more interesting. I have already mentioned that in addition to the space-time relation, there is also a momentum-energy one, an explanation of the "red" shift, from which it follows that the masses of elementary particles depend inversely proportionally on the speed of the fundamental interaction. That is, the masses of elementary particles, and hence the masses of objects in general "there-then" and "here-then" are less than they are "here-now". But not only the gravitational "red" shift, but also **the gravitational field itself is a consequence of a change in the speed of the fundamental interaction. With a decrease in this speed, the gravitational field increases and manifests itself as an attractive one. With an increase in this speed, the gravitational field decreases and manifests itself as repulsive.**

Reduction of the speed of the fundamental interaction leads to one interesting effect, which could probably be verified experimentally.

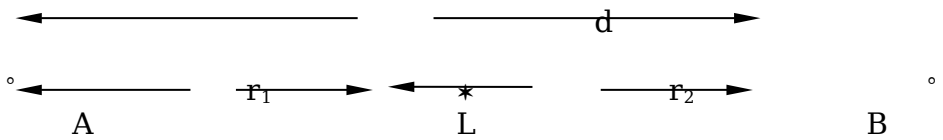

Fig. 5.

L is the Sun, A and B are artificial satellites located at the same distance from L ($r_1 = r_2$) and on opposite sides from L. Because the speed of the fundamental interaction of the Sun decreases, its gravitational potential increases. This should show up as follows. An observer on satellite A will find that the distance to the Sun

is slowly increasing. The observer on satellite B will find the same thing. But the distance between the satellites remains constant. (For simplicity, we will not consider the expansion of space caused by the global decrease in the speed of the fundamental interaction). And even if the change in distance turns out to be unattainable to the modern measurements, then $r_1 + r_2$ will still be greater than d.

Here I will once again focus on the problem of the constancy of the speed of light and the inconstancy of the speed of the fundamental interaction. The inconstancy of the speed of the fundamental interaction, whether it stands up in the form of a Doppler effect or a gravitational "red" shift, always leads to space-time changes. If the Doppler effect is equal to the value of z, or if the gravitational "red" shift is equal to the value of z, this means the following: a receding galaxy or the gravitational mass interacts with all other objects with a fundamental speed equal to $c^- = c(1 + z)$, but at the same time, the galaxy itself or the gravitational mass is receding, from our point of view, at a speed $V = z\ c$. So the speed of light from a receding or gravitating object for us in all trials will still be equal to c, i.e. 300,000 km/s. This is true for any observer.

Now we can define motion in general. **Motion is a change in the speed of the fundamental interaction, which manifests itself at the level of the phenomenon for the perceiving subject in the type (form) of spatio-temporal changes.**

Do you want to get nearer to any object? Consider first that you are a dedicated system, and all other objects in our Universe have a fundamental interaction speed greater than you do. And then expend energy so that the speed of your fundamental interaction becomes equal to the speed of the fundamental interaction of the object you need. When both speeds become equal, you have reached the object.

Here are the following five options for the world:

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena the masses of elementary particles and the gravitational potential are constant. **Such a world cannot exist.**

2. If the speed of the fundamental interaction decreases, then at the level of phenomena the masses of elementary particles and the gravitational potential increase. The gravitational field behaves like an attracting field. This is **our world**.

3. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena the masses of elementary particles and the gravitational potential decrease. The gravitational field behaves like a repulsive field. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena the masses of elementary particles and the gravitational potential are equal to zero. There is no gravitational field. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the masses of elementary particles and the gravitational potential are equal to infinity. This is **an anti-singularity**.

Special theory of relativity.

Actually, as such, the special theory of relativity does not exist now. And the difference between classical mechanics, special and general relativity can be determined only by the conditions of the problem and the permissible degree of error in the solution. But one important point must be emphasized.

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena, the speeds of objects do not exist. This is an impossible world.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena the speeds of all objects are less than the speed of light. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena the speeds of all objects are greater than the speed of light. This is **a time-reversed world**.

4. If the speed of fundamental interaction is equal to infinity, then at the level of phenomena the speeds of all objects are equal to infinity. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena all speeds are equal to zero. This is **an anti-singularity**.

From this it is clear how the **problem of the event horizon in the Universe** is solved. In the singularity state, all events in the universe are causally related. With the decrease in the speed of the fundamental interaction, an increasing share of the objects will go beyond the event horizon. But the Universe within the event horizon will always be causally connected. When the speed of the fundamental interaction is equal to zero, all events and objects of the Universe are situated beyond the event horizon. At the level of phenomena, the Universe ceases to exist. When the speed of the fundamental interaction increases, objects and events "enter" into the region of the event horizon.

Theory of elementary particles.

It has already been mentioned about the mass of elementary particles. As far as symmetries are concerned, in the microcosm, as well as in the macrocosm, all symmetries must be broken. This includes CPT symmetry [i.e., charge, parity, time-reversal]. From this it follows:

1. If the speed of the fundamental interaction is equal to some constant value, then at the level of phenomena the charges of elementary particles are constant. This is **an impossible world**.

2. If the speed of the fundamental interaction decreases, then at the level of phenomena the charges of elementary particles increase, having generally accepted signs of charges. This is **our world**.

3. If the speed of the fundamental interaction increases, then at the level of phenomena the charges of elementary particles decrease, and with it a reversal of the signs of the charges occurs. This is **a time-reversed world**.

4. If the speed of the fundamental interaction is equal to infinity, then at the level of phenomena the charges of elementary particles are equal to zero. This is **a singularity**.

5. If the speed of the fundamental interaction is equal to zero, then at the level of phenomena the charges of elementary particles are equal to infinity. This is **an anti-singularity**.

From this it is clear how the problem of **the baryon asymmetry [baryons are heavy particles made up of three quarks, i.e., protons and neutrons] of the Universe** is solved. In our world, from the very beginning of the exit from the singularity state, there is only matter. In the time-reversed Universe, from the very beginning of the exit from the anti-singularity, there is only antimatter.

Interpretation of the solution of Einstein's equations in the form of a spherically symmetric gravitational field.

The solution of the equation of such a field was given by Karl Schwarzschild. The rate of time flow on the Schwarzschild sphere is equal to zero, and its surface is infinite. While considering the issue, it is always said that time stops on the Schwarzschild sphere, but for some reason the infinite surface of the sphere is not mentioned. This situation is possible only under the condition that the speed of the fundamental interaction is equal to zero, that is, the object goes into **an anti-singularity.**

There is no doubt that the anti-singularity, like the singularity, indicates that here our assumptions are incomplete. But no one yet is able to give an exact definition of a singularity and an anti-singularity. This is the subject of a different theory with a different axiomatic system, since any actual infinity indicates a fundamental inadequacy of the assumptions. The singularity and the anti-singularity are the problem of problems.

But fortunately, we have an opening: we can consider not the singularity or anti-singularity itself, but an infinitely close approximation to them. For fundamental clarity of the picture, this is quite enough.

In the discussion of the problem of "black holes", such a picture is often drawn: a photon jumps out from the surface of the Schwarzschild sphere, but, not having the ability to overcome the gravity of the "black hole", again falls to the surface; or such as this: the speed of light becomes equal to zero and instead of a star, we now “see” a black spot. Nothing like that happens, of course. The speed of light measured at whatever proximity to the surface of the Schwarzschild sphere will still be equal to 300,000 km/s. Only the standards of length and duration change. But here the speed of the fundamental interaction at the level of the noumenon really tends to zero. And this change in the speed of the fundamental interaction for a distant observer will manifest itself only in a change in the space-time characteristics of the "black hole", namely: "red" shift. A star, turning into a "black hole", for a distant observer will rapidly go to the event horizon, that is, move away. Moreover, for an observer located on the other side of the collapsing star, it will move away at exactly the same speed, but in the opposite direction. And the test particles of both observers will never catch up with the departing star, although the observers may well exchange test particles or light signals with each other. In other words, the distance of the collapsing star located midway between the two observers remains constant, but the distance from each observer to the collapsing star tends to infinity. (We will not now take into account the slight increase in this distance due to the expansion of space in our Universe) And this is not some apparent effect, but for our world of phenomena, a very real one. This situation is shown in Fig. 6.

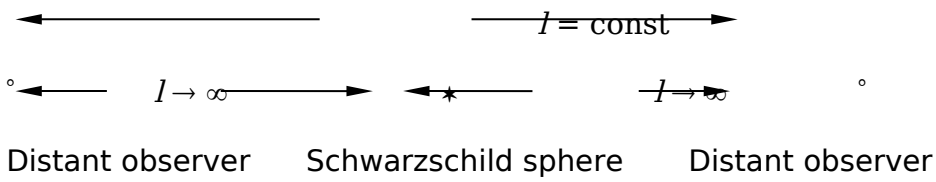

Fig. 6.

Isn't it true that the interpretation presented here is significantly different from the interpretation of gravitational collapse that can be found in any relevant textbook or in the popular science literature? And one more thing: this picture is reminiscent of something already known. Yes, namely it's the quasar. Quasars in cosmology are considered objects located far beyond our own and other galaxies, for the reason that their speed approaches the speed of light. It is believed that even if they were formed in our galaxy or a galaxy close to us, they would have “jumped” out of their borders long ago. In fact, if the collapsing star were among observers located in the sphere, then they, after adequate parleys, reflections and general discussion, would come to the conclusion that the collapsing star is located inside the sphere formed by the observers themselves, and at the same time it is rapidly going beyond the event horizon of the Universe. Thus, the quasars now known to science are quite possibly located within the boundaries of our Galaxy and present themselves as collapsing stars, although the distance to them tends to infinity. That is, we see the

process of the formation of a "black hole". We will probably never be able to see the "black hole" itself, even more so never approach it.

Inside the Schwarzschild sphere, the reversal of the signs of space and time occur. This means only one thing: the speed of the fundamental interaction is increasing. At the level of phenomena, this will manifest itself in an increase in the rate of the flow of time and the compression of space. At the same time, time "flows" from the future into the past, all interactions are advanced. This, in turn, means that spherical waves come from infinity, which are absorbed in electrons. And the Schwarzschild sphere for an observer located inside it will just be infinity.

Everything else (reduction of entropy, etc.) is clear from the aforementioned. Such an inverted world will evolve to a singularity state.

Expanding Universe.

I propose such a plot of the expanding Universe.

In the singularity state, when the speed of the fundamental interaction is infinity, the Universe has the following properties:

1. The Universe is a point that has no dimensions.

2. The pace of the flow of time in this Universe is equal to infinity, that is, all events occur in one instant, which has no duration.

3. Energy, momentum, angular momentum of the Universe are equal to infinity.

4. All symmetries are absolutely broken.

5. The variation of any action is equal to minus infinity.

6. All effects exist.

7. The entropy of the Universe is zero.

8. The mass of the Universe is zero.

9. The gravitational potential of the Universe is equal to zero.

10. The speed of the interaction between objects of the Universe is equal to infinity. All events are causally related.

11. Charges of elementary particles are equal to zero.

This series can be continued.

As I already said, I don't know how the Universe can get out of the singularity state. Most likely this is not just a physical problem. But let’s propose that the speed of the fundamental interaction begins to decrease, and the Universe leaves the singularity state. It does not occur in the noise and roar of the Big Bang or the great anguish of Inflation, but rather in the quietness of its Radiance and Glory.

The Universe begins to expand, its volume increases. The pace of time appears. Now the Universe has not only a present, but also a past and a future. Elementary particles acquire charges. The entropy of the Universe begins to increase and galaxies, stars, planets appear from absolutely ordered structures. Since the laws of conservation of momentum and angular momentum are violated, the objects of the Universe rotate, and this rotation slows down. The masses of objects and the gravitational potential are growing. In other words, we see the world that we see. This world is evolving to an anti-singularity state.

It is not so easy to draw a picture of the world reversed in time. Let physicists or science fiction writers try to do it.

And only now we can say that such a world is completely determined. This is evolutionary determinism, which is the only one that is possible. This world is by now very dissimilar from the world that modern physics explores with the help of its laws. At the level of appearance, it is finite in space and time, and it arises from nothing.

Quantum theory.

There is no randomness in the world just described. But this problem is completely solvable.

Ilya Prigogine in the book “From Being to Becoming” [«От существующего к возникающему»] expressed the idea that “... we will need one way or another to give up the fundamental difference between pure and mixed states and the privileged position of pure states. Therefore, the problem is to identify thoroughly the differences between pure and mixed states.”

Actually, the concept of a “pure” state means that a quantum mechanical system does not interact with anything. It is to some degree analogous to the definition of inertial systems. Now we can introduce the provision that **"pure" quantum-mechanical states do not exist**.

If the speed of the fundamental interaction between two objects (or in the object itself) is equal to infinity, then at the level of the phenomenon the distance between them (or in the object itself) is equal to zero. Furthermore, at the same time, the speed of the fundamental interaction between these objects can be equal to some finite, but changing value. Between objects there is an interaction with the help of light and the interaction, which is now tentatively called in physics a "non-information", "non-force" interaction. Furthermore, its speed is acknowledged as equal to infinity. This is instant long-range action. **Short-range interaction, that**

is, interaction with the help of light, is responsible for cause-and-effect relationships (structures). And the instant long-range action violates causality (since cause and effect are simultaneous in this case), introducing randomness into the world.

A special "carrier" of such randomness is an electron. They say that an electron, if it does not interact, is “smeared” over some space, situated immediately “everywhere”. In reality, the space in which the electron is "smeared" represents a point for the electron itself. When it interacts, for example, with a photon, then it interacts precisely at its **point**, but for us it is in a certain **volume**. Therefore, there is no fundamental possibility to determine in advance at what point in our space the interaction will occur. For an electron, all of this space is a **point**. And only for the subject perceiving the phenomenon, the **point** of the electron is represented by the **volume** of space in which interaction can occur. This, it seems to me, is an essential explanation for the randomness that really takes place in our world.

Now it should be clear why the Einstein-Podolsky-Rosen thought experiment is actually incorrect, and Bell's inequalities do take place. [EPR argued that quantum theory incorrect by highlighting entanglement, missing values to restore causality and locality; Bell’s theorem noted incompatibility of local realism and quantum mechanics, i.e., either locality or realism must be abandoned.]

I must also note that many difficulties in quantum theory can be eliminated if c is not equated to unity in advance, as is done in quantum electrodynamics and chromodynamics. c in this case is not the speed of light, but the speed of the fundamental interaction c, which is always different from unity, except for the case of “here-now”.

All of this and something beyond is presented in more detail and more convincingly, I hope, in my work **“Space and Time. /Physical aspect/”.** [**«Пространство и время. /Физический аспект/»** This is a larger essay not yet published of which **“Space and Time for the Science-Fiction Writer”** is a brief summary.]

Conclusion

For myself, I have worked out the physical aspect of the concept of Space and Time, and I do not intend to deal with this problem further. The further development of this **evolutionary theory of relativity**, as I would like to call it, is not my concern. Although I have a clear idea of what needs to be done for a certain group of physicists to quickly and mathematically reliably work it out, combining all areas of fundamental physics into a common picture.

And here’s one more point. In this work, I often wrote: "... such and such a physicist was mistaken ...". Yes, from my point of view, this physicist is wrong. But this does not mean at all that I regard these physicists and their ideas with some kind of contempt. On the contrary! I have always been amazed and delighted by how did these ideas come to people's minds? There are no absurd ideas in physics! And the "entelechy" of Aristotle, and the "impetus" of the medieval scholastics, and the

"phlogiston", and the "law of conservation of matter", and the "constancy of the speed of light", and everything else that is accepted and rejected by modern physics—all this—magnificent and delightful ideas. I have already written with what pleasure I read the works of Albert Einstein and Ilya Prigogine. Not a single work, not a single physicist or philosopher has caused me a skeptical smile. It was interesting to me. Political denunciations in physics and philosophy constituted the only exception. These, of course, were abhorrent to me.

And now there is another point in my subconscious, that asks that it be put into words. But to do this takes time.

Ah, yes. Again, time...

March 1993

Two women in Russia, Olga Kolupaeva and Irina Nikienko, have been extremely helpful in making this translation possible by supplying resource material and offering suggestions when the translation required them. I am deeply indebted to them. Of course, any error in the translation are mine.

--Bill Kuntz